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PROGRESS REPORT
of the
ANIMAL HUSBANDRY RESEARCH DIVISION
AGRICULTURAL RESEARCH SERVICE

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This progress report includes a summary of the current research of the Division and a preliminary report of progress made during the preceding year. It is primarily a tool for use of scientists and administrators in program coordination, development and evaluation; and for use of advisory committees in program review and development of recommendations for future research programs.

The summaries of progress on USDA and cooperative research include some tentative results that have not been tested sufficiently to justify general release. Such findings, when adequately confirmed, will be released promptly through established channels. Because of this, the report is not intended for publication and should not be referred to in literature citations. Copies are distributed only to members of Department staff, advisory committee members and others having a special interest in the development of public agricultural research programs.

This report also includes a list of publications reporting results of USDA and cooperative research issued between July 1, 1967, and June 30, 1968. Current agricultural research findings are also published in the monthly USDA publication, Agricultural Research. This progress report was compiled in the Animal Husbandry Research Division, Agricultural Research Service, U.S. Department of Agriculture, Agricultural Research Center, Beltsville, Maryland.

UNITED STATES DEPARTMENT OF AGRICULTURE

Washington, D.C.
July 1, 1968

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INTRODUCTION

This Animal Husbandry Research Division progress report is written in the same problem oriented pattern as the Long Range Study. The progress report shows what is being done, both basic and applied, to solve the problems that face the livestock and poultry industry and the progress being made in achieving the objectives. The result is a better picture of the current situation, and a clearer view of what still needs to be done.

Research in livestock production will benefit the public through lower-cost animal products and an assured supply of high quality foods more suited to the needs of consumers. It assists individual farmers by lowering costs and increasing net income.

The mission of the Animal Husbandry Research Division is to conduct research which will reduce costs of animal production, provide the consumer with animal products of improved quality, and provide a fund of basic science information to draw upon in the future. More and more of the easy steps toward production efficiency are being solved. Now progress is more difficult because the problems are more complex. New basic information on the genetics, physiology and nutrition of livestock is needed. Our scientists are having to place increasing emphasis upon basic research and the study of problems in depth.

The investigations of the Animal Husbandry Research Division are carried out by a staff of approximately 475 persons, of whom about 117 are scientists in the intramural programs of research. The work is conducted at Beltsville and at field locations throughout the United States. Many of the projects are carried out in cooperation with State agricultural experiment stations, other divisions of ARS, other Federal agencies and non-Federal organizations. The extramural programs of research include seven domestic scientists and the equivalent of 16 scientists participating in some 40 PL 480 projects.

It is frequently costly and unwise to make extensive program shifts until a promising and worthwhile research project is completed. Furthermore, most animal husbandry investigations are necessarily long term in nature. Consequently, it is easy to lose sight of the degree to which progress has been made in a yearly report such as this. A few of the more recent developments which have been marked contributions to industry and/or to public and industry research activities are mentioned briefly in the examples of progress that follow.

Selected examples of significant research findings

New test for detecting leukosis viruses. A NP test (non virus producing Rous sarcoma tumor cells) has been developed for detecting the leukosis-sarcoma group of viruses in chickens. The new test is more reliable, specific and sensitive for detecting the presence of the virus than are other tests now in use. The NP test can be used by breeders, vaccine producers and researchers to identify those birds which are free of the avian

lymphoid virus infection. By popular request from the industry and research laboratories, a workshop was held to explain the details of the new test. (RPA 211)

Genetic resistance to Marek's disease. Cooperative research with Cornell University has demonstrated that controlled exposure to the Marek's disease (acute leukosis) agent is an effective method of identifying resistant stock. Three generations of selection for resistance in one line and susceptibility in another has produced lines which are widely separated in mortality from the disease. This method is being tried by commercial poultry breeders in an effort to reduce losses caused by Marek's disease. (RPA 211)

Controlled multiple calving now appears possible. Results of research at the U.S. Range Livestock Experiment Station at Miles City, Montana, suggest that gonadotropic treatment of cattle can be successfully used to control the number of ova (eggs) released by beef cows. The latest study has resulted in the production of two corpora lutea per cow. If the number of ova released per cycle can be controlled in this manner, the beef calf crop percentage could be doubled. Another study to stimulate multiple births in beef cattle through hormone treatment was successful at Fort Reno, Oklahoma. The 48 cows that conceived produced 25 singles and 23 multiple births (12 twins, 6 triplets, 2 quadruplets, and 1 quintuplet). Live calves included 24 singles, 24 twins, 12 triplets, 3 quadruplets, and 2 quintuplets. While these results are preliminary, they provide a significant and practical step toward multiple birth control in beef cattle. (RPA 310)

Non-protein nitrogen can be used by ruminants as efficiently as protein. Energy metabolism studies with dairy cows that received 90 to 100% of the dietary nitrogen as urea showed that the efficiency of utilization of energy was equal to that obtained from rations containing natural sources of protein. Therefore, dairy cattle can convert efficiently such nitrogen sources as urea into milk protein.

Limitations to the complete replacement of proteins by non-protein nitrogen in the diet of cattle are being studied. Microbiological studies indicate that one of the limitations of non-protein nitrogen utilization in beef cattle is the insufficient microbial production of certain ruminal acids. (RPA 311)

Length of machine milking influences the leucocyte count in the mammary gland. Recent findings indicate that machine milking caused a decrease in leucocytes in the subcutaneous abdominal vein of the cow. This suggests that leucocytes are moving from the blood stream into the mammary gland of the cow in response to the mechanical irritation of the milking machine. This leucocyte movement increased as the duration of milking was lengthened. This indicates that the longer it took to machine milk a cow, the greater was the movement of leucocytes into the mammary gland, and the greater the likelihood that high leucocyte counts in milk will occur. (RPA 211)

A new practice in the control of Staphylococcus infections. A test dipping solution used after each milking dramatically reduced the resident Staphylococcus population on the ends of teats of treated dairy cows. The active ingredient of the dip was the commercial organic germicide "chlorhexidine," used at 0.2%. Further preliminary studies indicate that the practice is effective in preventing new mammary gland infections in cows exposed to high populations of Staphylococcus aureus. If related studies in progress are successful, the application of this simple practice could reduce sharply the incidence of mastitis and abnormal milk production. (RPA 211)

One cause of fertilization failure discovered. Plastic devices placed in the uterus of ewes resulted in failure of sperm transport to the oviducts and, thus, failure of fertilization. Uterine contraction of treated ewes moved toward the cervix whereas in control ewes, the contractions moved towards the oviducts. This difference in the nature of motility patterns strongly suggests that failure of sperm transport and ovum fertilization is caused by reversed uterine contractions. These results raise the possibility that a large part of the normal occurring fertilization failure in farm animals may be due to defects in uterine motility and sperm transport mechanisms. (RPA 310)

Sperm cells separated by weight differences. Conflicting reports have been made in the scientific literature about sedimentation as a means of separating female and male determining sex cells on the basis of weight differences. Workers at Beltsville, in cooperation with colleagues at the Armed Forces Institute of Pathology, appear to have succeeded in developing a procedure which yields heavier sperm at the bottom of a column after whole semen is allowed to sediment. In the study of semen from bulls and rabbits, the cells in the bottom fraction were significantly heavier than those from the top. The main feature of these experiments has been the application of quantitative electron microscopy in determining the weights of individual sperm cells. This technique will be useful as a check on sedimentation results in continuing experiments aimed at influencing sex ratio. (RPA 310)

Use of genetically superior sires reduces cost of milk production. Experimental evidence proves that genetic merit of dairy sires, as provided by USDA, is directly related to the income over feed cost performance of his daughters. For each 100-pound increase in a sire's USDA derived Predicted Difference, each of his daughters will average an additional \$3.22 more income over feed cost. Since genetically superior bulls are now easily identified and readily available through artificial insemination, farmers will have convenient access to genetic material that will increase incomes and profits while reducing the cost of production. (RPA 313)

Estrogenic-like effect of DDT. It has been found that op'-DDT, an isomer present in technical DDT, produces the same estrogenic response in the rat uterus as the female sex hormones, estradiol. Studies with chickens and quail also demonstrates that op'-DDT stimulates the reproductive tract of

birds much like estrogen. These results suggest the possibility that the op'-DDT in our environment may cause reduced reproductive efficiency in mammals and birds. (RPA 213)

Lighting feedlots increases feed efficiency. Beef cattle in the feedlot do about one-fourth of their feeding at night. When feeders are lighted continuously, cattle space their time at the feeders more evenly. Preliminary studies indicate that when feedlots are lighted continuously, cattle make equal gains with a 10% decrease in feed required per pound of gain. Color of light as involving red, green, blue and white, was not an influencing factor. (RPA 311)

Cereal grains for egg production. Barley, oats or wheat fed in practical diets balanced to supply equal energy intake supports egg production equal to that of corn. Efficiency of feed utilization, body weight gains and mortality were the same for all grains studied. The similarity of the reproductive performance from the use of any of the farm grains gives the producer greater flexibility in diet formulation and this will result in a decreased cost of egg production. (RPA 311)

Flies controlled without spreading insecticides. Certain insecticides eliminated fly breeding in cow manure when fed at low levels as part of the ration. Feeding one of them (Gardona) at 48 ppm in the ration resulted in manure which was entirely lethal to house fly larvea. Milk produced from cows on this ration was free from residues. The cows showed no adverse physiological effects from the treatment. Since some species of flies breed only in fresh cow manure and many other species use it extensively, this relatively simple method of control could have widespread application. Fly populations could be controlled without fear of contaminating the environment with pesticides. This method is being investigated further. (RPA 701)

Early pregnancy test for sheep. It has been found that use of the Doppler technique to detect fetal sounds provides a highly accurate and practical pregnancy test near the end of the second month of pregnancy in ewes. This permits ewes to be sorted into pregnant and non-pregnant groups for more efficient feeding and management. Earlier culling of barren ewes is aided and rebreeding of open ewes is facilitated. (RPA 310)

Simulated sonic booms disregarded by mink. Female mink exposed to simulated sonic booms raised litters of normal size. Pregnant and nursing mink were exposed to eight simulated booms per day. Exposed mink appeared to do as well as those not exposed, as measured by percentage of females giving birth, number of kits born per female, and litter size at 10 days of age. There was no clear evidence that repeated simulated booming increased nervousness in mink. (RPA 214)

CONTROL OF DISEASES OF LIVESTOCK AND POULTRY
(RPA 211)

USDA and Cooperative Program

Location of Intramural Work	Commodity	Scientist
		Man-years FY 1968
Georgia	Poultry	2.0
Maryland (Beltsville)	Poultry	0.6
Michigan	Poultry	10.8
Mississippi	Poultry	1.6
Maryland (Beltsville)	Sheep	0.2
Texas	Sheep	0.1
Total		15.3

Intramural program is supplemented by extramural support representing
(a) 0 SMY's at State Agricultural Experiment Stations,
(b) 1.2 SMY's at other U.S. institutions, and
(c) P.L. 480 funds in 3 countries representing \$97.4 thousand equivalent.

Problems and Objectives

Infectious diseases represent the single greatest hazard to the production of an adequate and wholesome supply of animal protein. They are a constant threat to the livestock or poultry producer, who can be wiped out of business by a catastrophic disease outbreak. This hazard increases as the prevalence and severity of a disease increases. The total losses to the public from animal diseases will exceed \$2.6 billion annually by 1980, if continued at the present rates. Losses result from mortality, reduced productivity, cost of treatment or immunizations, cost of regulatory programs, and condemnations of meat at the slaughterhouse. Some diseases which cause losses in animals are also transmissible to man.

Major objectives of the research are to:

1. Reduce condemnation losses from avian leukosis in broilers and mature birds.
2. Reduce mortality and morbidity losses from avian leukosis in chickens.
3. Reduce losses from airsacculitis in poultry.
4. Reduce losses from metabolic disorders in ruminants through improved production practices.
5. Reduce losses from mastitis in dairy cattle by determining biological and environmental causes and by developing improved diagnostic procedures.

Progress--USDA and Cooperative Programs

A. Poultry

1. Avian leukosis complex. Extramural research on the pathology and etiology of Marek's disease at Arkansas indicates that gross skin lesions were reproduced with 3 Marek's disease (MD) isolates in 3 different strains of chickens, but the incidence was low in all instances. Line 7 chickens obtained from the Regional Poultry Research Laboratory, East Lansing, Michigan, and exposed to the dust of a chicken house developed skin lesions. Environ D and Cresylic acid, when applied to the skin, were very irritating but did not increase the occurrence of skin leukosis. Negative results were obtained in 3 experiments in attempts to reproduce MD with the lesser meal worm or the Hister beetle. Studies show that lymphocytic infiltration of dermal nerves and lymphocytic follicular masses surrounding feather follicles would appear to be specific for MD of the skin. (03 29 029)

Extramural work at California is conducted on the detection and identification of etiological agents of Marek's disease. Marek's disease (MD) isolate C-1 has been studied during 20 serial transfers with blood and tumor suspensions in chickens. Buffy coat fraction appears to be more potent than whole blood. Kidney cell cultures inoculated with C-1 isolates developed degenerative changes and caused MD in chickens inoculated. Control cultures had similar degenerative changes, but did not cause MD in chicks. Electrophoretic analysis of serum showed a marked increase in serum globulin and a decrease in albumin after infection and survival. Attempts to immunize birds were

made. Challenge indicated some immunity; however, neutralization tests for antibody gave negative results. (03 29 030)

Progress reported to date from a contract at Connecticut includes the production of antisera in rabbits inoculated with fluorocarbon extracted tissues from MD-infected chickens. This antiserum gave a reaction with antigen from infected birds which was absent in control antigen and could be absorbed with infected tissues, but not control tissues. MD infectivity in plasma was inactivated by pH 9.2, but not with pH 5.2. Virus-like particles were observed in plasma pellets and lymphocytes from MD-infected birds. (03 29 063)

Cooperative research at Georgia on reservoirs of Marek's disease (MD) indicates that neither mosquitoes or mites are likely vectors for the agent of MD. Attempts to transmit the disease with mosquitoes which had engorged on MD-infected chickens were unsuccessful except when such mosquitoes were homogenized and inoculated intra-abdominally into susceptible chicks. Likewise, mites obtained from houses with flocks with a high incidence of MD were non-infectious when administered to test chickens by natural or experimental routes. In other trials, litter and other organic material from houses containing infected chickens failed to induce gross MD lesions in test chicks in four weeks. (03 29 062)

At Massachusetts, attempts have been made to infect avian cells, principally chick kidney cells and, although, infectivity has persisted short periods of time, evidence for propagation of the agent has not been obtained. Initial attempts to characterize JM agent in plasma preparations were unsuccessful since infectivity was not demonstrated even prior to treatment. (03 29 033)

At Beltsville, stocks of inbred chickens varying in their susceptibility to three subgroups of the avian leukosis-sarcoma viruses have been assembled for studies of the mechanism of resistance. Representative commercial lines of chickens are being surveyed for patterns of resistance to three viral subgroups. Considerable variability has been found within and among lines. These results indicate that most stocks of economic value carry genes for resistance to the avian leukosis-sarcoma group of viruses, which can be rapidly increased in frequency through appropriate selection methods. (03 29 064)

Studies of the genetics of resistance to lymphoid leukosis and Marek's disease is underway at the Regional Poultry Research Laboratory at East Lansing, Michigan. Preliminary findings indicate that the inheritance of resistance to lymphoid leukosis and Marek's disease appears to be independent. Also it appears that the genetic control of resistance to lymphoid leukosis is expressed in two ways: a) resistance to cellular infection by the virus, and b) resistance to tumor development if the cells are infected. (03 29 027)

In studies of genetic lines of chickens free of leukosis, a total of 9 inbred lines or sublines have been introduced into the specific pathogen free (SPF) program. All are now free of the leukosis/sarcoma group of viruses. All lines and isolators have been sampled for Marek's disease herpesvirus and found to be negative. All birds have also been tested and found free of infection with *S. pullorum* and *gallinarum*, *M. gallisepticum*, infectious

bronchitis, and avian encephalomyelitis. (03 29 038) In another study of the genetic control of Marek's disease, the initial selection of chickens surviving inoculation with the JM isolate of Marek's disease has been made to initiate a line selected for resistance by individual selection. Breeders to start a line to investigate the possible correlated responses of economic traits to selection for resistance to Marek's disease are being reared. (03 29 095)

Studies of sex chromosome of cells from tumors obtained in the transmission of Marek's disease have revealed that most tumors are of host origin. This indicates that most Marek's disease isolates cause tumors by induction rather than by transplantation. However, some isolates result in some birds with donor type tumors indicating that transplantation does occur. Recognition of this possibility is important in genetics as well as in other experimental transmission studies. (03 29 071)

Skin grafting is being studied as a possibility for developing isohistogenic sublines. The intent is to develop isohistogenic sublines in lines 6, 100, and 15I. Subline 1 of line 6 has accepted all reciprocal grafts for the last four generations and appears isohistogenic. However, second set grafts have not yet been attempted to substantiate this status. Line 100, which has not yet been repopulated on a subline basis, exhibits very few rejections at 37 days. However, at 269 days, an increased rejection rate occurs within certain sex exchange patterns. Even so, the results indicate that the development of isohistogenic sublines can be accomplished fairly readily. Progress for the three sublines of line 15I has been temporarily halted as the current generation had heavy losses from Marek's disease and must therefore be repopulated. (03 29 083)

In a study of the immunity of chickens to avian tumor viruses, the complement fixation test for avian leukosis (COFAL) and the fluorescent antibody (FA) test were standardized and put into operation to supplement other testing methods in studies of lymphoid leukosis. Studies on the inactivation of lymphoid leukosis virus by various inactivating agents showed that an immune response was obtained only when the virus was incompletely inactivated. However, many birds with high neutralized antibody titer later died of lymphoid leukosis. With complete inactivation, no immune response was detected and no tumors resulted. (03 29 024)

An investigation of genetic variation in the control of antibody production in response to antigen stimulation is under way. Microtechniques and tannic acid sensitization of sheep red blood cells have been tried and found adequate to determine the antibody titer to BSA immunization. The experimental determinations remain to be performed. (03 29 082)

Further research at the Regional Poultry Laboratory at Michigan is aimed at developing methods for the assay of Marek's disease in cell cultures. The following observations were made on the association of a cell-associated herpesvirus (MDHV) with Marek's disease (MD): MDHV was isolated from each of 6 laboratory MD inoculation of chicks and cell cultures; 64 produced similar results by both methods. Fifty-five of 57 MD inoculated cultures with MDHV

plaques reproduced MD in chicks and agreement between plaques and infectivity was obtained for 87% of 131 cultures tested. These and other data constituted circumstantial evidence which strongly suggested that MDHV was an etiologic agent of MD. In vitro assays for MDHV were developed and evaluated. Direct kidney culture from test chicks was the most sensitive method. Material could also be assayed by inoculation of chick kidney cells or duck embryo fibroblasts. These tests were of equal sensitivity, but 0.8 to 2.3 logs less sensitive than chick inoculation. The JM isolate of MD was used to test the relative susceptibility of line 1900 SPF chickens. The response obtained was primarily extensive hemorrhages in the connective tissue occurring earlier than the neural lesions seen in 15x7 chickens. This is the first recorded occurrence of such lesions in MD. An isolate of RE virus was propagated in chicken embryo fibroblast. The supernatant after processing by the Molony procedure caused peripheral nerve lesions indistinguishable from those caused by MD isolates. The virus was re-isolated from liver, spleen, whole blood, and plasma. Electron microscope studies of the re-isolated virus revealed particles with morphology similar to that described for the RE virus. (03 29 081)

Studies of the pathogenesis of Marek's disease and lymphoid leukosis indicate that chickens infected with LL virus are more susceptible to transplantable tumors than are normal chickens. Studies with phytohemagglutinin (PHA) indicate that cells of the MD lesion do not react normally to this reagent and a higher proportion of such cells develop type A inclusion bodies. (03 29 078) Cytological studies of fixation procedures have revealed that Zenkers fixative without acetic acid or formalin is better than others tested for the fixation of wet smears of tumors. Such smears stained with methyl green pyronin, Ehrlich's hematoxylin or Shorrs stain revealed striking differences between tumor cells of Marek's disease and lymphoid leukosis. Those of the former are pleomorphic, lymphocytic cells and variable in staining reactions, whereas those of the latter are all lymphoblast which are uniform in morphology and staining. (03 29 077)

In continuing studies of the avian leukosis complex, it has been found that testosterone propionate administered in safflower oil by subcutaneous injection produces an early atrophy of the bursa of Fabricius and this in turn prevents the development of lymphoid leukosis. The extent of atrophy and reduction of tumors was found to be directly related to the dosage of testosterone. Almost complete suppression of the disease was obtained with 80 mgs of the hormone and 30 mgs reduced deaths from leukosis to about one-third that of the controls. (03 29 036) Further studies of androgen analogs, which may be useful for bursal ablation as a means of controlling losses from lymphoid leukosis, have identified 2 compounds of promise (in cooperation with the Upjohn Company). Both compounds, when fed at selected levels, caused sufficient bursa atrophy to prevent the development of LL. One of these did not appear to impair the vitality of the test chicken. Continued studies with this compound are in progress. (03 29 076) Enzyme activity of embryo tissues of lines 6, 7, and 15I was compared. The activity of the dehydrogenases, lactate, malate, isocitrate, and succinate was higher in the 20-day embryo bursa of Fabricius of line 15I than for either lines 6 or 7.

Similar differences were found in the spleen, dehydrogenases and bursa DNP diaphorase. No significant differences were detected in tissues of chickens 3-4 weeks of age. (03 29 099)

In the study of antigenic and host range characteristics of the leukosis-sarcoma viruses, a survey of 114 serums from 5 field flocks for antibody against subgroups A, B, and C Rous sarcoma viruses has been completed. The results indicate a relatively high incidence (10-83%) against subgroup A RSV, lower incidence (3-34%) against subgroup B RSV, and no positive sera were detected against subgroup C viruses. A state of defectiveness in the standard Harris strain of RSV has been observed by the isolation and propagation of a "helper" virus and RSV nonproducer (NP) cells. Biological properties of the myelocytomatosis virus (MC-29) indicate that it possesses the properties of the lymphoid leukosis-sarcoma complex in that it shows RIF and COFAL activity and will activate NP cells. Subgroup characterizations indicate it to be a mixture of both subgroup A and B types. (03 29 070)

Intensive ultrastructural studies by simultaneous light and electron microscopy have been made to determine the histological lesions specific to Marek's disease. Such studies have revealed the morphological features of MD lesions and demonstrated the presence of a degenerative lymphoblast (MD cell) in tumors and nerve lesions. Presence or absence of this cell could be used for differential diagnosis of MD. The search for the presence of herpes-type virus in tumors and nerve lesions has resulted in finding this virus in lesions of some birds and ultranuclear inclusion bodies and other nuclear abnormalities that could indicate the presence of the viral genome in tumor cells. (03 29 075)

Indirect immunofluorescent staining technique has been applied to the detection of Marek's disease (MD) antigens in cell cultures and antibody in sera of birds. MD antigen could be detected in the nucleus and in the cytoplasm of chick embryo fibroblasts, duck embryo fibroblasts, and chick kidney cells infected with material known to contain the MD agent. Uninoculated cultures of chicken cells were always free of MD antigen, and serums from control birds did not stain the MD antigen. However, duck cells contained granules which fluoresced with the serums. Using known infected chick kidney cultures, antibody could be detected in the sera of infected and recovered birds and was absent in sera of control birds reared in isolation. In a cross fluorescence test, 8 different strains of MD could not be distinguished from one another on the basis of the antigens detected by the immunofluorescence test. The agar gel precipitin of Chubb and Churchill is in many ways comparable to the FA test for antibody. (03 29 072)

Research on the auto-immune pathogenesis of Marek's disease indicates that chickens with Marek's disease were found to have an increased level of gamma globulin and affected nerves with anti-nerve antibodies suggesting some type of an auto-immune phenomena. (03 29 073)

Etiological studies of Marek's disease indicates that MD associated herpes-virus is in all the different strains of the disease studied with the

electron microscope (JM, GA, C-1, MS-50). Attempts have been made to propagate this virus in different cell cultures, thereby increasing the titer of the virus and possibly producing cell free infectious virus. Some success has been encountered using chicken embryo fibroblast cultures. Cytopathological, histochemical, and other ultrastructural investigations have definitely placed the virus of Marek's disease in herpesvirus classification. A greater number of virus particles are observed by the electron microscope in infected duck fibroblast than in chicken embryo fibroblast or chick kidney cell cultures. However, only chicken embryo fibroblast cultures were found capable of producing cell free virus. (03 29 074)

In research on the mechanism for the natural transmission of Marek's disease, trials were done to evaluate the potential MD infectivity of poultry byproduct meal and feather meal prepared from chicken carcasses condemned for leukosis. Samples were tested by feeding to MD susceptible, isolator-reared chicks which were examined for gross MD lesions and presence of MD virus. All of 6 samples derived from different rendering plants at different times failed to induce a MD response in the test chicks. (03 29 079)

A study of genetic resistance to Marek's disease continues under contract at New York. The third generation of selection for resistance and susceptibility to inoculating with the JM strain of Marek's disease has continued to show remarkable progress. The 8-week inoculation test resulted in 7.3% mortality in the resistant line and 94.4% in the susceptible line. These results suggest that a progeny inoculation test may be a very useful method of selection for resistance to Marek's disease. Tests of these and other lines under natural exposure conditions are in progress. (03 29 028)

In Israel, a Brown Leghorn infection-free laying flock has been established in newly completed isolation units. Isolation cages for experiments with Marek's disease have been installed. The COFAL, RIF, BHT tests for lymphoid leukosis virus have been standardized and compared. The mortality of 9 flocks of chickens over a period of 10 to 28 weeks of age was examined. It was found that of 368 necropsies, 5.7% had lymphoid leukosis and 17.4% had Marek's disease. (03 29 040)

2. Newcastle disease. In the study of genetic resistance and susceptibility of chickens to the Newcastle virus, results of 352 ten-day embryo challenge tests indicated that the line selected for resistance to GB-Newcastle disease vaccine was significantly more resistant than that selected for susceptibility. Screening of 2-week old progeny using more than 1,500 pedigreed chicks, indicated that average times to death after inoculation were 8.9 and 8.2 days for the resistant and susceptible lines, respectively. However, individual dams and sires within lines continued to deviate from expected performance and correlations between embryo and chick test results were low, which indicates that the genetic basis for response to NDV challenge is not simple. The use of such stock in genetic-environment interaction experiments should lead to increased test sensitivity and studies on physiological parameters within these populations should give knowledge of mechanisms for physiological resistance to respiratory diseases. (03 29 042)

In studies of blood changes related to broiler losses, tests have been made of the major chemical constituents of the blood of broilers in several experiments. Only slight differences, if any, have been observed. It would appear that homeostatic compensations were enough to keep the blood constituents relatively constant under the experimental conditions used. More drastic changes than in the energy level of a well-fortified broiler mash or more virulent pathological infections are required in the experiments to show significant change of major constituents of the blood. Total serum protein and blood glucose are influenced by so many factors that the experiments must be carefully planned to eliminate variables before significant differences may be observed. For example, blood glucose was found to decrease after 24 hours fasting, but was back to normal after 72 hours fasting. Experiments having a physiological approach are in progress and are showing significant differences. (03 29 090)

In a study of nutritional influences on broiler losses caused by disease, infection of broiler chickens with Mycoplasma gallisepticum (MG) increased condemnation and mortality and reduced feed consumption, efficiency, and body weight gains when compared to non-infected groups. A high energy level, which was obtained with 6-1/2% poultry oil in the ration, was found to offset some of the adverse effects of MG infection, when compared to a low energy ration with 1-1/2% poultry oil. The use of 50 or 100 lbs/ton of feather-meal in the ration depressed body weight gains and feed consumption. (03 29 085)

3. National Poultry and Turkey Improvement Plans. In work on the control of hatchery-disseminated diseases at Beltsville, it was found that approximately 70% of the chicks and 90% of the poults produced in the United States are produced by voluntary participants in the program. In 1967-68, 741 chickens (.002%) of the 33.5 million tested for pullorum-typhoid reacted to the test. This is an increase over the .001% for 1966-67 and is the first increase since 1961-62. Nineteen reactors were found in one of the 1,386 turkey flocks tested. The number of chickens in the U.S. M. Gallisepticum Tested class, which was added to the program in 1966-67, increased from .9 million to 2.4 million, while the percentage of birds reacting to the M. gallisepticum test decreased from .52 to .14. Reactors in turkeys decreased from .275% to .073%, and flocks including more than 90% of the turkeys in the program were classified as U.S. M. Gallisepticum Tested. Flocks containing over 90% of the 3.5 million participating turkeys also qualified for a typhimurium classification. This compares to 87% last year and 82% the year before. The number of reported typhimurium isolations during this 3-year period that the program was available decreased from 54 to 23 cases. (03 29 059)

4. Avian anatomy. The manuscript for Volume I, "Avian Anatomy - Integument", is in the editor's hands. The 2,700 pages are divided into 10 chapters, 2 appendices, and literature cited. This is a long term project in basic research, designed to provide poultry scientists, professional poultrymen, veterinary anatomists, avian pathologists, laboratory diagnosticians, experimental zoologists, comparative anatomists, and those who

write textbooks with the most authoritative information possible on the chicken, turkey domestic duck, coturnix, and common pigeon. Research under this project has contributed extensively to establishing anatomical regions for the avian body, defining and naming feather tracts and featherless spaces, the timing of molt for each feather of the body, the development and microscopic structure of feathers, and the microscopic structure of skin and all of its appendages. Work has begun on the second volume, covering detailed anatomy and histology of the skeletal system of the chicken. Each bone, joint, ligament, muscle, and tendon will be dissected, drawings made, and described. (03 29 037)

B. Metabolic Diseases in Ruminants--Beef Cattle and Sheep

In the study of metabolic disorders in sheep, no signs of obstructive calculi were observed during a feeding period of 125 days. No calculi were recorded from the urinary tracts of any of the animals at termination of the feeding period. Apparently factors other than mineral level in the diet contributed to the formation of calculi in the Texas and South Dakota lambs. (03 33 010-1) In another study, based on the reduction in the incidence of calculi, gain of and feed efficiency of lambs, the various chemical compounds tested during the past several years with a diet known to produce calculi, may be ranked in overall effectiveness as follows: ammonium chloride, 100; ammonium sulfate, calcium carbonate and potassium bicarbonate, 75; potassium chloride and sodium carbonate, 50; ammoniated phosphoric acid and phytic acid, 25; calcium phosphate, diammonium phosphate, magnesium oxide, sodium chloride and metasilicate, 0. Dipotassium and disodium phosphates and potassium citrate tended to increase calculi formation. With ammonium chloride, it has not been necessary to make any change in management practices other than to add it to the diet. FDA clearance has been granted to add ammonium chloride to the diet at a level not to exceed 1.5 oz. per head daily for cattle and 0.25 oz. for sheep. (03 33 010-2; 03 30 028)

Analytical procedures have been developed in Israel for the assay of blood acetic acid, propionic acid and butyric acid. Blood values in $\mu\text{m}/\text{liter}$ averaged 606.65 for acetic acid, 25.28 for propionic acid and 25.85 for butyric acid in 86 lactating ewes. Corresponding standard deviations and ranges were 116.49 and 329-918, 16.24 and trace to 67, and 15.88 and trace to 63. Further determinations of blood fatty acids in relation to lactation, fasting and ketosis are being made. (03 33 022)

White muscle disease in Turkey has been reported in lambs since 1952. Occurrence has varied from flock to flock and from year to year in the same flock. Morbidity has ranged between 5 to 20% and up to 50% in some flocks. Mortality has been estimated at 22%. The disorder has been observed most frequently between April 15 and May 20 and mostly in lambs from 15 to 45 days of age. Sex and breed did not affect the incidence. Subcutaneous injections of sodium selenite (1%) resulted in 94% recovery of affected lambs. Vitamin E (500 U.I.) given orally resulted in 94% recovery but a longer time was required. Combinations of sodium selenite and vitamin E resulted in 99% recovery. Sodium selenite given orally in the last two months of pregnancy did not affect the live weight of the lambs. Vitamin E given to pregnant ewes

caused an increase in birth and 30-day weights only in the pure Akkaraman female lambs and not in the male lambs nor in the Merino-Akkaraman cross lambs. Selenium given to male lambs (average 3 weeks old) had no effect on 60-day live weights of male lambs, but a negative effect on female lambs. Vitamin E given directly to lambs had no effect on live weight increases. (03 33 024)

C. Mastitis and Mammary Gland Defenses--Dairy Cattle

Studies concerning the effectiveness of using a post milking teat dip to reduce the incidence of bovine mastitis have produced encouraging results. In short term trials consisting of 42 cows divided into two groups, a dip containing 2,000 ppm chlorhexidine virtually eliminated the large resident population of organisms capable of growing on Staphylococcus Medium 110 (Difco Laboratories). The technique developed for evaluating the effectiveness of the dip solution in these studies should prove valuable in screening other compounds for probable effectiveness.

Cows in two environmental chambers were used for an intensive study on the effectiveness of the teat dip in preventing new udder infections. After preliminary samplings to determine the status of each quarter, two quarters of each cow were designated for the post milking dip and two quarters were used as controls. Prior to milking, the milking machines were dipped in a culture of Staphylococcus aureus. After 6 months, only 3 of the dip protected quarters have become infected compared to 18 of the control quarters.

Studies concerning the role of the leucocyte in the body defense mechanism indicate that machine milking stimulated movement of the leucocytes from the blood into the mammary system. Improved methods of counting cells in milk have been developed. (03 31 044)

A contract to evaluate the effectiveness of a national abnormal milk control program was initiated late in FY 1968 at North Carolina. (03 31 075)

Publications--USDA and Cooperative Programs

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2. Newcastle disease

None

3. National Poultry and Turkey Improvement Plans

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4. Avian anatomy

None

B. Metabolic Diseases in Ruminants--Beef Cattle and Sheep

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C. Mastitis and Mammary Gland Defenses--Dairy Cattle

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CONTROL OF INTERNAL PARASITES OF LIVESTOCK AND POULTRY
(RPA 212)

USDA and Cooperative Program

Location of Intramural Work	Commodity	Scientist	
		Man-years FY 1968	
Maryland (Beltsville)	Sheep		0.1
		Total	0.1

Intramural program is supplemented by extramural support representing

- (a) 0 SMY's at State Agricultural Experiment Stations,
- (b) 0 SMY's at other U.S. institutions, and
- (c) P.L. 480 funds in 0 countries representing \$0 equivalent.

Problems and Objectives

Internal parasites, such as various kinds of worms, flukes, and coccidia cause losses in all parts of the country and in all seasons. In general, warmth, moisture, and shade favor parasites. About 300 kinds are of economic importance in the United States and will cause losses estimated at \$650 million annually by 1980 at present rates. Severe infestations of parasites may cause heavy direct losses to the livestock producer, but internal parasites generally are unseen, their effects are not apparent, and the loss to the public from inefficient production is hidden. Losses include mortality, reduced yield, condemnation of meat, feed wastage, and cost of drugs. Even for the parasites that have been the subject of considerable research, treatment as control measures are far from adequate. Losses attributed to helminth parasites of sheep in 1965 amounted to \$26 million.

Major objectives of the research are to:

1. Reduce losses from helminth parasites in sheep by increasing genetic resistance.
2. Develop improved husbandry and management practices in sheep to minimize the effects of parasitism.

Progress - USDA and Cooperative Programs

A. Sheep

A study was conducted with 40 head of lamb to determine the carry-over of internal nematode parasites from one grazing season to another on contaminated pastures. The experimental period was from May 10 to October 10. Haemonchus contortus, Ostertagia circumcincta, and Strongyloides papillosus increased in numbers gradually until the end of the grazing period. Continual exposure to species of Nematodirus appeared to bring about an acquired resistance after 3 months. (03 33 016)

Publications - USDA and Cooperative Programs

A. Sheep

Colglazier, M. L., I. L. Lindahl, J. H. Turner, G. I. Wilson, G. E. Whitmore, and R. L. Wilson. 1968. Effect of management systems on the growth of lambs and development of internal parasitism. II. Field trails involving medication with national formulary and purified grades of phenothiazine. J. Parasit. 54:89-97.

PROTECT LIVESTOCK AND POULTRY FROM TOXIC
CHEMICALS, POISONS AND OTHER HAZARDS
(RPA 213)

USDA and Cooperative Program

Location of Intramural Work	Commodity	Scientist
		Man-years FY 1968
Maryland (Beltsville)	Beef cattle	0.3
New York	Other animals	0.5
	Total	0.8

Intramural program is supplemented by extramural support representing
(a) 0 SMY's at State Agricultural Experiment Stations,
(b) 0 SMY's at other U.S. institutions, and
(c) P.L. 480 funds in 0 countries representing \$0 equivalent.

Problems and Objectives

Livestock and poultry may suffer losses in productivity from pesticide residues remaining on crops used for animal feed. Residues of chlorinated hydrocarbons accumulate in body fat and become concentrated under certain conditions. Accidental animal poisoning claimed the lives of at least 3,097 farm animals in 1967.

Major objectives of the research are to:

1. Determine the metabolic fate of pesticides in biological systems.
2. Determine the physiological effects of pesticides on animals.

Progress - USDA and Cooperative Programs

A. Beef Cattle

Treatment of beef heifers with systemic, organo-phosphate insecticides (Ruelene[®] or Co-Ral[®]) during early stages of pregnancy through in-house research at Miles City, Montana, failed to indicate deleterious effects on embryo development. No effect was noted on conception rate, number of services per conception, or embryo survival. (03 30 039-3) Related work at Crawford, Nebraska, suggested treatment on day 40 of gestation had a teratogenic effect on the embryo. The effect resulted in a missing or constricted segment of the colon of the newborn calf. However, subsequent studies involving 99 cows treated during the suggested "critical period" including days 35 to 46 of gestation failed to confirm the initial finding. (03 30 039-2)

B. Fur Animals

Pure p,p' DDT was fed to mink for three generations. No deleterious effects were noted through the second generation. The results of the growth and reproductive performance of the third generation are currently being analyzed. Since this study was initiated, ARS scientists and others have determined that o,p' DDT has estrogenic activity in rats and mice which could seriously affect reproductive and growth performance. Technical grade DDT, which is the product usually used in commercial spraying, contains approximately 15-20% o,p' DDT and 80% p,p' DDT. Assays of the estrogenic activity of o,p' DDT in mink are currently being conducted and, if possible, further work will be initiated to determine the effects of this chemical on reproductive performance and growth in mink. (03 34 005)

Publications - USDA and Cooperative Programs

None

PROTECT ANIMALS FROM HARMFUL EFFECTS OF AIR POLLUTION
(RPA 214)

USDA and Cooperative Program

Location of Intramural Work	Commodity	Scientist	
		Man-years FY 1968	
Maryland (Beltsville)	Poultry		0.8
		Total	0.8

Intramural program is supplemented by extramural support representing
(a) 0 SMY's at State Agricultural Experiment Stations,
(b) 0 SMY's at other U.S. institutions, and
(c) P.L. 480 funds in 0 countries representing \$0 equivalent.

Problems and Objectives

Fluorides, atmospheric lead, nitrogen oxide, carbon monoxide, carbon dioxide, and ammonia are some of the chemical contaminants found in the atmosphere and which may have harmful effects on livestock and poultry. This problem area also includes the study of adverse effects of sonic boom on farm animals. Of particular concern is the distinct possibility of "startle effect" on animals subjected to sonic booms from aircraft.

Major objectives of the research are to:

1. Determine the specific effect of air pollution on farm animals.
2. Determine the specific effect of sonic boom on farm animals and particularly on mink.

Progress - USDA and Cooperative Programs

A. Livestock and Poultry

An extensive review of literature was conducted at Beltsville on the effect of air pollution on the performance of livestock and poultry. The pollutants considered were as follows: ammonia, arsenic, beryllium, cadmium, carbon monoxide, carbon dioxide, dioxane, fluoride, hydrocarbons, lead, manganese, mercury, molybdenum, nitric oxide, nitrogen dioxide, sulfur dioxide, sulfur trioxide, vanadium, zinc, mists and vapors, ozone, smoke, and combinations of two or more air pollutants. The general observations from the 525 papers reviewed were that at least 50% of the reports are concerned with laboratory experiments, rather than toxicities occurring in the field. Fluorides appear to be the major pollutants affecting cattle, sheep, and horses; ammonia, carbon monoxide, carbon dioxide, and dusts are primarily concerned with poultry; no definite trends were observed among the air pollutants for swine and other animals. The results of laboratory studies have suggested that combination of two or more pollutants was more toxic than when the compounds were administered singly. (03 29 093)

Publications - USDA and Cooperative Programs

None

REPRODUCTIVE PERFORMANCE OF LIVESTOCK AND POULTRY
(RPA 310)

USDA and Cooperative Program

Location of Intramural Work	Commodity	Scientist
		Man-years FY 1968
Maryland (Beltsville)	Poultry	4.6
Louisiana	Beef cattle	0.8
Maryland (Beltsville)	Beef cattle	0.5
Montana	Beef cattle	2.2
Oklahoma	Beef cattle	0.9
Maryland (Beltsville)	Dairy cattle	4.6
Maryland (Beltsville)	Swine	1.9
Nebraska	Swine	0.2
Idaho	Sheep	1.2
Maryland (Beltsville)	Sheep	0.5
New York	Other animals	0.2
Maryland (Beltsville)	Pioneering labs	3.0
Total		20.6

Intramural program is supplemented by extramural support representing

- (a) 0 SMY's at State Agricultural Experiment Stations,
- (b) 0.3 SMY's at other U.S. institutions, and
- (c) P.L. 480 funds in 3 countries representing \$231.7 thousand equivalent.

Problems and Objectives

Brood animals fail to come in heat, fail to conceive, abort with embryonic deaths, have stillbirths or lose their offspring in postnatal deaths. Poultrymen have no way of ensuring that all eggs incubated are fertile, nor of hatching all those which are fertile. Attainment of optimum reproductive efficiency could decrease the cost of producing our annual crop of calves, pigs, lambs, chicks, and poults by \$2 billion. For example, it costs \$80 a year to keep a beef cow. Maintenance of the 10.4 million beef cows that will fail to raise a calf in 1980 at current rates of reproduction would cost the public \$832 million. Similarly, dairying production costs would be increased by \$482 million, poultry production by \$155 million, hog production by \$143 million, and lamb production by \$82 million. The potential benefits from research on reproductive efficiency could be even greater as a result of awarding current losses and by increasing the number of offspring produced per breeding female each year.

Major objectives of the research are to:

1. Increase the number of living young produced from each breeding female per year in chickens, turkeys, beef cattle, sheep, swine, and fur animals.
2. Increase the number of eggs produced per turkey and broiler breeder per year.
3. Reduce losses from barren females and shorten the calving interval in dairy cattle.
4. Synchronize estrous, especially in beef cattle and swine.

Progress - USDA and Cooperative Programs

A. Poultry

Continuing research on parthenogenesis in avian eggs has shown that through selection of Pozo Gray (PG) turkeys, unorganized parthenogenetic development has been increased over a 6-year period from about 1% to 25%. No parthenogenetic embryos have been encountered in PG eggs in spite of intensive selection. Beltsville Small White (BSW) turkeys of the high incidence strain, maintained at Pennsylvania State University (PSU) for two generations, have continued to produce parthenogenetic eggs at a rate comparable to controls at Beltsville, but the numbers of embryos going to full term and hatching have decreased. Unselected stocks of BSW turkeys from this station have been maintained for a number of years at PSU in the absence of fowl pox virus. When eggs of such stocks were tested, both at PSU and at Beltsville, parthenogenetic development was found to be approximately 4% or about 1/4 of that produced at Beltsville by unselected but vaccinated birds. This would seem to indicate some association of the virus and parthenogenesis. At Beltsville in 1968, a total of 30 parthenogens were hatched from 7,678 unfertilized eggs. (03 29 019)

Adrenalectomy, thyroidectomy, or castration caused distinct morphological changes in the hypothalamic neurosecretory cells, but no significant alterations in the content of aldehyde-fuchsin stainable neurosecretory material (AFM) in the storage depots in the median eminence or neurohypophysis. Adenohypophysectomy or total hypophysectomy led to massive degeneration and loss of cells in the hypothalamic nuclei, with some slight loss of AFM in the median eminence depot. Cell losses in the supraoptic nucleus were significantly higher following total hypophysectomy than following adeno-hypophysectomy. (03 29 021)

Implantation of minute amounts of crystalline progesterone into selected brain areas evoked premature ovulation in the hen. Implants of estrogen delayed ovulation, while implants of testosterone or cholesterol had no effect. Delays in ovulation following implantation of estrogen into the preoptic brain were of the same magnitude as those evoked earlier by electrical stimulation of this site. Blood flow through the hen's ovary, as estimated by the fractional distribution of Rb^{86} was 1.2 ± 0.7 ml per gram per minute. Rate of blood flow through the ovulable follicle was significantly higher at 30 minutes before ovulations than at 10 hours before ovulations. Injection of an ovulatory dose of purified mammalian luteinizing hormone increased blood flow in the follicle. These results are contraindicative of a role of reduced blood flow in follicular rupture for ovulation. (03 29 045)

Methods have been established for the determination of progesterone and its derivatives in ovarian and peripheral blood of the laying hen. These methods involve separation of the hormones from lipids present in the plasma, their purification by chromatographic techniques, and their quantitative determination by gas chromatography and competitive protein binding. Work is in progress on determination of the levels of progesterone and its derivatives in the plasma of the laying hen at regular intervals throughout the ovulation cycle. (03 29 046)

Hatchability of fertile eggs from linoleic acid deficient hens was reduced to nearly zero as compared with 75% hatch of fertile eggs from hens receiving 3% linoleic acid. The major peaks of mortality occurred between 0 and 4 days and 20 and 22 days. No specific pathologic lesion was found to account for the excessive mortality. The majority of the linoleic acid deficient embryos that survived to 22 days were in an abnormal position in the shell with head over right wing rather than under the wing. Linoleic acid deficiency decreased egg weight, percentage of yolk, dry matter, lipid and caloric content. (03 29 065)

The follicular growth response on the ovaries after the injection of pregnant mare serum was less in linoleic acid deficient hens than in nondeficient hens. Linoleic acid deficient hens had smaller anterior pituitaries

than replete birds and cellular changes in the pituitary and hypothalamus were observed. These changes may have been the result of hormone imbalance in the linoleic acid deficient hens. (03 29 066)

Artificial insemination studies in Israel indicate that *Mycoplasma gallisepticum* (MG), when shed with sperm, is capable of infecting chicken hatching eggs and embryos. Addition of MG cells increases infertility by 20% probably due to competition with the sperm for energy. The MG cells do not survive long enough to infect the oviduct, but their presence permits other organisms to do so. Hens with high estrogenic activity, unlike mammals, are not less susceptible to infections of the reproductive tract than hens with low activity. The total number of bacterial cells in semen samples studied seems to be positively correlated with hygienic conditions on the farm. The results imply that sanitation is a pertinent factor in the improvement of fertility. Several antibiotics have been evaluated, in vitro, for effect on flora prevalent in the semen of cocks. Marked differences in the inhibitory effects have been observed. (03 29 047)

Attempts were made to fertilize ova of White Leghorn (WL) laying hens with semen of Broad Breasted Empire White turkey toms in another study in Israel. The primary objective - "to improve fertility of chickens by selecting for breeding those individuals which showed the highest level of fertility," was not attained, although, several important findings were recorded: (1) Turkey semen was found to contain a strain of E. coli which caused high mortality in WL hens when deposited in hens' oviducts above the uterovaginal junction, but was not pathogenic in the oviducts of turkeys. Turkey sperm, when free of E. coli and placed in the magnum of the oviduct of WL hens, did not cause high mortality. (2) Histological studies of oviducts of WL hens showed that most turkey sperm did not reach the tubular glands of the infundibulum, a factor believed to account, at least in part, for the low fertility and the short sperm life within the hen's oviduct. A higher degree of fertility resulted when sperm were placed above the uterovaginal junction than when deposited in the vagina. (3) No parthenogenesis was encountered upon incubating for 10 days unfertilized eggs of WL hens. (03 29 048)

B. Beef Cattle

In in-house work at Jeanerette, Louisiana, in 1964 and 1965, Angus, Brahman, and Brahman x Angus crossbred pregnant yearling heifers were placed on different treatments about 60 days before calving. Cows have been kept on these same treatments since initiation of the study. The treatments were: (1) pasture only (some roughage was fed in winter), (2) drylot fed to make similar weight gains or losses as cows on pasture, (3) drylot fed ground hay, corn, and cottonseed meal to supply a calculated 9.0 lbs. of TDN while dry and 16.0 lbs. of TDN while lactating, and (4) pasture and supplemented similar to cows in lot 3 during the winter and early spring period. The average pregnancy rates of all cows by treatment for 1967-68 were:

(1) pasture only 65%, (2) drylot low level 46%, (3) drylot higher level 54%, and (4) pasture higher level 89%. A digestion trial was conducted of the rations fed in drylot. The ration fed to lot 3 cows supplied only 13.4 lbs. of TDN. Angus cows nursing calves in drylot had higher pregnancy rates, but gave less milk and weaned lighter calves than crossbred or Brahman cows nursing calves. Lactating Brahman and crossbred cows on pasture, and supplied with supplemental feed, had a slightly higher pregnancy rate, 90% and 92%, respectively, than Angus cows, 80%, kept in the same environment. Failure to show heat was the major cause of nonpregnancy. Cows fed the higher nutritional levels had shorter intervals from calving to first heat than cows kept on the lower nutritional levels. Angus cows and crossbred cows had shorter intervals from calving to first heat than Brahman cows. Milk production decreased more rapidly for cows on pasture than for cows in drylot. (03 30 029)

At Beltsville, heifers which were fed an all-concentrate diet since 84 days of age were more efficient than heifers fed a high-roughage diet. Heifers implanted with diethylstilbestrol (DES) gained faster, were more efficient, and reached puberty sooner than heifers without DES. Growth and reproductive performance of beef heifers were not significantly affected by feeding a poor quality 50% forage diet in which two-thirds of the total dietary nitrogen was supplied either as soybean meal, 1/2 SBM and 1/2 urea, or urea. Several normal calves have been born to heifers fed a protein-free purified diet since 84 days of age. Urea was the sole source of nitrogen in the diet. Bulls fed the same diet were mated to the heifers. Growth, reproduction, and lactation are, therefore, possible without dietary protein. The cattle have been on the study for 3-1/2 years at the present time. (03 30 026)

Data from two years of in-house study at Miles City, Montana, indicated low levels (6.25 mg.) of follicle stimulating hormone (FSH) exert a predictable stimulation of ovarian activity in beef cattle. Average ovulation rate was 2.16 with 60% of the animals responding with either double or triple ovulations. Increasing FSH dosage resulted in essentially a linear dose-response relationship for all ovarian data obtained. FSH dosage resulted in a significant ($P < .05$) curvilinear depression in numbers of sperm per ova. Mastectomy of beef heifers resulted in a marked shortening of the interval from calving to first postpartum estrus. Fertility at this first postpartum estrus was low. Using existing gross techniques, no gonadotropic hormone has been detected in blood obtained from ovariectomized heifers. Moisture content of range forage ranged from 64% to 66% during the period from calving until adequate forage was available to produce weight gains in lactating cows. Feeding cows grain during the period from calving to adequate grass resulted in an increase in calf weight gains. Weaned heifer calves were fed to gain 0.61, 0.99, and 1.49 lb. per day during the 152-day wintering period. Percentages of heifers exhibiting estrus prior to the beginning of the breeding season were 6.7, 24.1, and 80.0, respectively, for the three feed groups. (03 30 008)

At the Fort Reno station in Oklahoma, 26 2-year-old Hereford-Angus crossbred cows and 43 mature Hereford and 12 mature Angus cows were treated with two subcutaneous injections of PMS: 1500 I.U. on day 4, 5, or 6, and 2000 I.U. on day 16, 17, or 18 of the cycle. On day of estrus, 2500 I. U. chorionic gonadotropin was injected intravenously, the cows hand mated, then pasture exposed for the remaining 2 to 3 months of the breeding season. Conception rate at first post-PMS estrus was 64.2%, and overall was 87.7%. Forty-eight cows that conceived at the first post-PMS estrus produced 25 singles and 23 multiple births (12 twins, 8 triplets, 2 quadruplets, and 1 quintuplet). Live calves included 24 singles, 24 twins, 12 triplets, 3 quadruplets, and 2 quintuplets. Average gestation lengths and birth weights of male and female calves, respectively, were: singles--280.8 days, 83.3 and 83.1 lbs; twins--277.4 days, 66.2 and 59.8 lbs; triplets--269.2 days, 45.7 and 46.6 lbs; quadruplets--262.5 days, 38.7 and 35.8 lbs; and quintuplets--258.0 days, 29.9 and 30.1 lbs. Eleven of 15 crossbred cows and 12 of 33 mature cows produced multiple births. Retained placentas were associated with 11 multiple births and 1 single birth. (03 30 013)

Further research results to date (10 years) on the performance of beef heifers and cows under different winter feeding treatments indicate that both the low and very high levels of supplemental winter feeding have an adverse effect on survival rate, percent calf crop, and milk production of spring calving beef cows. (03 30 031)

C. Dairy Cattle

In research at Beltsville on the importance of immunogenetic factors in fertility, several different sets of electrophoresis conditions were studied to determine which procedures give the best resolution of the proteins of seminal plasma from bulls and rabbits. Four different procedures appear to detect variation in protein patterns between individual males. To date, four different protein patterns have been found in bulls and at least four in rabbits. Whether or not these variations are characteristic of the individual animals remains to be seen. Current studies have the objective of determining whether the variation has a genetic basis and whether it is related to fertility. (03 31 004)

In studies of endocrine control of reproduction at Beltsville, acute infection induced in the sheep uterus on the day following estrus inhibited formation of corpora lutea. Infection in one uterine horn inhibited luteal development on the adjacent ovary but not on the opposite ovary, implicating local utero-ovarian pathways in the luteolytic mechanism.

Estradiol injected into ewes on the 11th and 12th days of the estrous cycle hastened regression of the corpus luteum. Estradiol had no effect in hysterectomized ewes, indicating involvement of the uterus.

Both mucopolysaccharide (MPS) content and the level of vascular function in the endometrium of ewes were high during estrus and low during the luteal phase. Intrauterine devices (IUDs) raised the MPS content and level of vascular function. IUDs also intensified acute leukocytic responses to semen and to bacteria. Results indicate that IUDs cause basic changes in physiology of the endometrium.

Uterine contractions of estrous ewes, recorded in vivo, moved predominantly toward the oviducts. IUDs caused most contractions to move toward the cervix; reversed contractions probably explain inhibition of sperm transport by IUDs.

Subjecting rams to 32°C for 4 days decreased sperm quality and lowered ovum fertilization rates in ewes bred to the rams. (03 31 060)

Further study of hormonal regulation of reproduction, the presence of foreign objects in one uterine horn of the ewe inhibits sperm transport and ovum fertilization on both sides of the reproductive tract. Drugs and hormones that affect uterine motility did not overcome the anti-fertilization effect of intra-uterine devices (IUD) in ewes. After 150 million sperm were deposited in a ligated uterine horn of estrous ewes, more than half of the sperm disappeared within 5 hours. With an IUD in place, half of the sperm disappeared in 1 hour. Washing uterine lumens before depositing sperm did not reduce spermicidal activity, but excising the uterus eliminated sperm disappearance. Results indicate the production of spermicidal substances by the uterus after sperm were placed in the uterine lumen. This may be a major factor in some types of infertility in farm animals. (03 31 073)

In research on sperm cell separation at Beltsville, a medium was developed for sedimentation of spermatozoa which appears to bring about a separation on the basis of weight. The medium is prepared from a mixture of 55% fresh egg yolk and 45% of a 20% glycine solution by centrifugation for one hour at 34,000 x G at 4°C. The supernatant was used to fill glass columns of 1.1 cm diameter to a height of 14 cm. After sperm sedimentation proceeded for 30 minutes at 30°C, fractions were removed by way of the top of the column. In three experiments with bull sperm using this medium, the median dry mass of populations of sperm from the bottom fractions of the columns were 6.8, 6.2, and 3.0% heavier than sperm from the top fractions. In two experiments with rabbit semen, sperm from the bottom fractions were 1.6 and 3.8% heavier than cells from the top fractions. The two fractions were separately but simultaneously subjected to density gradient centrifugation in sucrose and the cells of the two fractions always banded at equal densities. This is considered proof that their physical state was comparable. Further studies are needed to confirm these preliminary results. The medium which was developed to provide these results has a serious drawback - it severely reduces sperm motility. Therefore, if the separation by weight is confirmed, it will be necessary to modify the medium before sex ratio studies can be made. (03 31 064)

In cooperative work at Wisconsin, evidences for local control mechanisms operating between the uterus and the ovary have been demonstrated by the prolonging action of unilateral hysterectomy and by the shortening action of intrauterine devices on the life of the corpus luteum in cattle, sheep, and guinea pigs. They have also been demonstrated by intrauterine administration of benzyl alcohol in the sheep and by the necessity for the presence of the uterine horn on the same side of the body as the corpus luteum for induced regression of the corpus luteum by exogenous oxytocin in cattle or exogenous progesterone in sheep and cattle. Possible local action of the uterus in determining the time of resumption of follicular development has also been demonstrated following parturition in the cow. Attempts to demonstrate a reciprocal local effect of the ovary on the histology or motility of the ipsilateral nonpregnant uterine horn have failed. (03 31 037)

In India, palpation data on ovarian activity in water buffalo were collected from 14 villages in three areas adjacent to the city of Anand. The data are now being collected for the second year. A cursory look at the data indicates that the so-called "seasonality" of breeding is man made because buffalo are showing feeble signs of heat during the "nonbreeding" season. The tendency for the right ovary to be more active than the left reported by other workers has been confirmed. Observations on genitalia collected from a slaughter house revealed similar trends. All 24 buffaloes maintained at the Institute showed signs of estrus during the "nonbreeding" season, and 19 of them actually conceived. The average number of services per conception was 1.6. Results virtually eliminate seasonal anestrus. (03 31 048) In another study of male and female sex hormones in India, several azasteroids have been synthesized and a number of intermediates necessary for the next phases of azasteroid syntheses have been obtained. Azasteroids IV and V, which bear a close relationship to the quilenin structure, were shown to inhibit the stimulatory effects of testosterone on the ventral prostate and seminal vesicles in rats. (03 31 035)

Research on repeat breeder cows and heifers is underway in Israel. Embryo recoveries from 118 cows slaughtered between 11 and 19 days post ovulation showed that repeat breeder cows contained fewer embryos than did normal cows through the entire period. Embryo losses in repeat breeder cattle occur much earlier than previously thought. Recovered ova showed some abnormal, apparently unfertilized ova, as well as cleaved ova that did not develop beyond the 4-cell stage, indicating the importance of conditions affecting ova while still in the oviduct. In cattle without embryos, corpora lutea weighed less and adrenal glands weighed more than in cattle with embryos. In addition, repeat breeders without embryos had heavier thyroids than those with embryos. These differences are fairly consistent and hint at possible connection of these glands with infertility. Cystic corpora lutea do not appear to be associated with lowered fertility, at least during the first few weeks after breeding. Histochemical studies showed no differences between normal and repeat breeder cows or between pregnant and nonpregnant animals. Phosphorylase activity was shown only by the luteal cells of corpora lutea of pregnancy.

The pattern of peripheral blood plasma progesterone concentrations in cycling cows was established. Progesterone levels were lower for the period of 3 days before estrus to 5 days after estrus than during the rest of the cycle. Encouraging results have been obtained towards developing a reliable and sensitive biochemical assay for estrogens based on gas chromatography of heptofluorate derivatives of estradiol or estrone. (03 31 049)

D. Swine

In the study on synchronization of estrus in swine at Beltsville, 289 gilts and sows in two successive years were group-fed a daily ration of 2.27 kg. containing 125 mg. of 1- α -methylallylthiocarbamoyl-2-methylthiocarbamoylhydrazine (ICI 33,828). Six replicates were treated the first year, and five were treated the second year. Treatment was initiated at unknown stages of the estrous cycle and continued for 20 days. All animals were bred by natural service. Eighty-one percent of the animals expressed estrus on the fifth, sixth, or seventh day after the end of treatment. The mean number of days required to return to estrus was 5.5. The conception rate after first service was 89.6%. The farrowing rate of the first service animals was 86%. Litters averaged 9.5 pigs born alive. The data show that ICI 33,828 was effective in controlling the estrous cycle and synchronizing estrus of sows and gilts; resulted in good reproductive performance; and can be recommended for use in regular swine production units. (03 32 008)

Research at Beltsville indicates that boar spermatozoa have widely different fatty acid composition. Choline phosphatide, the predominant phospholipid, contains 40% docosapentaenoic acid, while ethanolamine phosphatide and serine phosphatide contain 32% and 13%, respectively. Docosahexaenoic acid is present at 25 and 21% in the choline and ethanolamine phosphatide fraction and 5% in the serine phosphatides. Stearic acid was the predominant fatty acid in serine phosphatides at 33%. Total unsaturated fatty acids ranged from 74% in the choline phosphatides to 35% in the serine phosphatide. The high percentage of unsaturated fatty acids in the sperm cell may contribute to specific membrane permeability and the ability of the cell to withstand the freezing process. Freezing to -196°C . causes 70 to 83% of the glutamic-oxalacetic transaminase (GOT) and 12% of the lactic dehydrogenase (LDH) enzyme activity to be lost from the spermatozoa into the seminal plasma or semen extender. An abrupt drop in temperature (25°C . to 0°C .) caused a 7 to 11% loss of GOT and 2% loss of LDH from the spermatozoa. These results indicate that changes in GOT activity in spermatozoa may be an extremely useful parameter for assessing freezing and storage damage. (03 32 009)

The study of genetic variability in gene pools of swine is underway at Lincoln, Nebraska. Selection for high ovulation rate (number of corpora lutea) has been carried through one generation. Laparotomies in 106 high-line and 121 control-line gilts revealed 14.4 and 14.6 corpora lutea, respectively. The corresponding averages for litter size at birth were 8.8 and 8.7 pigs. Thus, no genetic control of these characteristics has been demonstrated thus far. (03 32 010)

Basic research is underway in Israel on factors acting on long-term storage of sperm in vivo. Three organs in which spermatozoa are stored for considerable periods served for the study of sperm preservation in vivo: the hen oviduct, the ram epididymis, and the spermatheca of the queen bee. Spermatozoa injected into the lumen of various ligated regions of hen oviducts in vivo and recovered after 24 hours showed that the lower part of the isthmus and the magnum also have a considerable sperm-preserving ability. Chemical constituents which were detected in ram epididymal fluid included free fatty acids, amino acids, amines, peptides, fructose, inositol, transaminases, and para-cresol. Free fatty acids and amino acids may represent an additional energy-source in the epididymal semen, but their importance in the ejaculate may be small because of the large amount of fructose there. In the hen oviduct, the spermatozoa are stored in a motionless state, and they maintain an aerobic metabolism, the rate of which is perhaps increased under the influence of the oviduct secretions. In the ram epididymis, the spermatozoa are motile and they maintain both an aerobic and anaerobic metabolism for which the substrates are available in the epididymal fluid. In the queen bee's spermatheca, the spermatozoa are stored in dense motionless masses, can be activated by iso osmotic dilution per se, and maintain a glycolytic and fructolytic metabolism. (03 32 026)

Also in Israel, work is underway to improve fertility by devising methods for separating old and new spermatozoa. A direct method for determination of dry matter percentage in bull spermatozoa was developed. Dry matter content in ejaculated spermatozoa was found to lie in the range of 26.59% - 32.72% with an average of 29.74%; a significant difference was found between bulls. The specific gravity (S.G.) of spermatozoa from four consecutive ejaculates ranges from 1.0570 to 1.0967, with a significant difference between the ejaculates. Year-round data on the seasonal variation in the S.G. of spermatozoa and of seminal plasma indicate lower S.G. values during winter and higher values during summer. This phenomenon is more pronounced in the seminal plasma. The percent of total lipids in the dry matter of spermatozoa from four consecutive ejaculates was found to increase from the first to the third ejaculate and to decrease from the third to the fourth. The percent of cholesterol and phospholipids in the total lipids decreased from the first to the third ejaculate and increased from the third to the fourth. Insemination trials were carried out with separated spermatozoa from upper and lower fractions. For the few trials performed, a pronounced difference was found between the two fractions, with a higher 60 to 90 day non-return (fertility rate) for the upper fraction. (03 32 025)

E. Sheep

A rapid and accurate technique was devised for observing the reproductive tract of living ewes at the Sheep Experiment Station at Dubois, Idaho. This makes possible and practical the selection of ewes on the basis of ovulation rate to improve prolificacy. A practical ultrasonic Doppler technique was developed for diagnosing pregnancy in the ewe. This can improve efficiency in managing sheep and lead to important savings. It will also prove of great

value in research. The ovulation rate of ewes in Idaho was shown to vary seasonally. The middle of the breeding season was characterized by the highest ovulation rate. The lowest rate was observed in late winter near the end of the breeding season. This will help the producer to select the best time of year to breed. Pretreatment of lactating anestrous ewes with estradiol in the early postpartum period before conventional hormone therapy has been shown to increase the incidence of estrus and fertility. This constitutes important progress in devising a practical method of shortening the lambing interval. When this is fully accomplished, the economy of lamb production will be greatly increased. Intramuscular injections of pregnant mare's serum resulted in equal or better ovulation response than subcutaneous injections. The intramuscular route is much more rapid and, therefore, indicates a large saving in labor when these injections are required. (03 33 005)

Ram Epididymitis Organism (REO) transmission was studied by venereal and contact exposure of infected rams with clean, non-infected rams and clean, non-infected, vaccinated rams. Observations for lesions, C-F tests, and semen cultures were taken. The post-observation period to determine the extent of REO transmission has not been completed. It is hoped that this study will reveal how REO is transmitted in the ram flock. This information would prove valuable in controlling this disease. The incidence of REO in the Rambouillet, Targhee, and Columbia breeds, as measured by isolation of the organism in the semen culture, was 4.0, 4.4, and 4.6%, respectively. The incidence is very low compared to that in some blackface breeds in Idaho, which is as high as 30%. In another trial, 13 rams which had REO isolated from their semen but no palpable lesions were vaccinated with Ramedol, a commercial vaccine. Four weeks later, 38% of these rams had palpable lesions. This means that the vaccination in some way precipitated the lesions in these rams which were known to be carriers of the organism. (03 33 025)

Research is underway at Beltsville to develop a strain of sheep capable of reproducing more than once a year at any time of the year. A total of 43 ewes lambed twice in 1967. These had 154% lambs for the first lambing and 149% for the second. One ewe lambed within a six month interval and 17 ewes lambed within an eight month interval. Lambs born during the summer were smallest and weakest. Lambs born during May and June grew the slowest. Best reproductive performance was from the late fall mating with lowest performance from spring and summer matings. Sires are chosen on the basis of their mothers' performance. (03 33 028)

Further work at Beltsville indicated that pregnancy diagnosis was more than 99% accurate on 791 head of ewes using the Doppler ultrasound technique. The average length of time between detection of pregnancy and lambing was about 80 days. Positive echo ultrasound technique readings and negative Doppler results have indicated reproductive tract abnormalities. (03 33 026) In a further study of estrus in sheep, it appears that synchronization of estrus did not increase lamb production and may have caused a decrease. (03 33 006)

At El Reno, Oklahoma, growth performance of spring born lambs in a flock lambing twice a year was studied. Growth performance of spring born lambs is generally unsatisfactory in the Southwest. Lambs were not allowed to graze, were weaned at an average of 72 days and finished in drylot. The average birth date was April 2, and the average birth weight was 9.6 pounds. Of the 354 lambs born, 343 were marketed at an average of 157.5 days of age and 95.4 pounds in weight. Average daily gain from birth to weaning was 0.65 pound, from weaning to market was 0.47 pound, and from birth to market was 0.53 pound. Corresponding pounds of feed per pound of gain were 1.34, 7.03 and 3.74, respectively.

Lamb carcass traits were studied in lambs from Dorset X Rambouillet or western ewes sired by mutton breed rams. Ram lambs grew faster, reached slaughter weight at an earlier age, had higher daily gains throughout life and produced more muscle and bone in a shorter period of time than wether and ewe lambs. Ewe lambs grew slower, thus requiring more time to reach market weight, and produced carcasses that were fattest of the sexes - with wethers intermediate with respect to these characteristics. Carcass quality grade scores were highest for ewe carcasses as were palatability scores for tenderness, flavor and meat juice. Differences in growth and carcass composition were observed to be greater between sexes than were the differences in quality and palatability of prepared cuts of the carcasses. (03 33 017)

A study is underway in Israel to improve semen quality and storage in artificial insemination. Estrus length in 67 Awassi ewes varied from 16 to 84 hours with an average of 35.3 hours. Ram semen diluted with isotonic phosphate buffer containing fructose and incubated at 37°C. showed slight decline in motility and similar fructolysis at dilution of 800 or 400 x 10⁶ cells per ml. At sperm concentrations of 200 x 10⁶ or less, both motility and fructolysis were affected adversely. Ram and bull semen diluted with a yolk-glycine-citrate-fructose diluent showed slight decline in motility and similar metabolic rates at all dilutions tested. A perfusion cell was developed to provide a continuous flow of the suitable diluent through the sperm suspension. This prevented the accumulation of lactic acid and maintained the activity of the sperm. (03 33 023)

Investigations are being made in Poland to determine whether the control of the hypothalamus over the pituitary in lactation is stimulatory or inhibitory in sheep. This was accomplished by studying the effectiveness of lactotropin in restoring lactation after it was abolished by electrolytic lesions of the hypothalamus in lactating ewes. It appears that the role of the hypothalamus in controlling pituitary lactotropic secretion in sheep is not inhibitory in character, but is active and stimulatory in nature. Further progress was made in locating the areas of the hypothalamus associated with the secretion and release of the follicle stimulating hormone. On the basis of about 4,000 histological sections, the structure of particular areas of the hypothalamus

in sheep was reconstructed and designed in the triplanar system of Horsley-Clarke's coordinates. Construction of this stereotaxic atlas represents a significant advance in neurophysiology in sheep. (03 33 031)

F. Mink

The effects of simulated sonic booms were studied on two commercial mink farms during the gestation and whelping season of 1967 on 300 female mink and their progeny. Simulated booms were produced ranging from 0.5 to 2.0 lbs per square foot overpressure eight times daily during gestation, parturition, and early lactation. There was a slightly higher kit mortality in the boomed groups. Litter sizes were comparable, and the overall production per female on experiment was greater for the groups receiving the booms. Production in both groups could be considered normal.

In another study of environmental control in reproduction of mink, 20 proven adult female and 10 male mink were placed in a light-controlled room on a "six month year" schedule. On this schedule, six of the twenty females completed what would normally be a year's fur growth and reproductive cycle in less than nine months. (03 34 004)

G. Pioneering Laboratory

At Beltsville, the chemical composition of mammary gland tissue of normal lactating rats was compared to mammary tissue which developed during cancer development. Carcinogenesis was induced chemically by oral administration of 20 mg. of dimethylbenzanthracene to 50-day old female rats. Seventy-five percent of surviving rats developed tumors. The mammary tumor tissue had a very low fat content, only 0.5-1% of wet tissue weight, in contrast to normal mammary tissue which contained 13% lipid. Water content, on a fat-free basis, was similar. The mammary tumor tissue had a greater DNA content, suggestive of greater growth. Tumor and normal mammary gland tissue did not exhibit any differences in their ability to take up estrogen from solution when incubated in vitro with radioactive estradiol. (03 98 001)

Intrauterine contraceptive devices (IUDs) were made of monofilament nylon and inserted by a non-surgical technique through the cervical os of rats so as to lie wholly within the uterine lumen. Most devices were retained and exhibited local contraceptive action in uterine horns where placed, thus providing a new method for studying physiological and biochemical factors important to IUD function. In biochemical analyses done near the time of expected blastocyst implantation, IUDs had marked effects on glycogen, RNA, DNA and histamine concentration of the rat uterus. All of these constituents, except histamine, were significantly greater in uterine horns bearing IUDs than in contralateral control horns. Concentration of histamine was significantly lower in the IUD horn. There was little evidence that inflammation was present in horns having the devices. (03 98 003)

Information was obtained on the role of estrogen in the ovulatory cycle of the hen by studying the biochemical composition of the oviduct of laying and non-laying hens, and by comparing these with the oviducal composition of immature birds injected with estrogen. Exogenous estrogen first produced an increase in oviducal wet weight, water and sodium. Later cytoplasmic growth occurred when dry weight, potassium and RNA increased, while no changes in DNA were observed. The oviduct of the non-laying hen had a RNA:DNA ratio and a glycogen concentration comparable to that of chick oviduct. Two to 3 fold increases in oviducal glycogen and RNA:DNA ratios were observed in either the immature treated with estrogen or the laying hen. Estrogen has been proposed to act by increasing protein synthesis. Actinomycin D, an antibiotic which inhibits protein synthesis was used to block protein synthesis in rats, but was incapable of inhibiting the estrogen induced increase in glycogen synthesis. (03 98 004)

The time course of in vitro estradiol uptake by uterus was composed of an initial rapid phase, followed by a slower one, and saturation was not attained until 3-4 hours of incubation. Non-target tissues exhibited only a single phase of uptake, saturation being achieved in 60-90 minutes. Initial uptake of target or non-target tissues was not affected by pre-treatment in vivo with (a) estradiol or (b) antiestrogens, MER-25, clomiphene, CN-55,945-27 or by (c) boiling the tissues or (d) pre-incubation with N-ethylmaleimide. All these procedures lowered the second phase of uterine estradiol binding. The experimental data are consistent with the interpretation that initial in vitro uptake in the uterus is non-specific while the secondary binding reflects the affinity of specific receptor sites for estradiol. (03 98 005)

From basic research in Israel on the mechanism of lactation, the influence of the pineal gland on the development of the mammary gland and on the release of lactogenic hormones was determined. The milk yield of pinealectomized mothers from days 14 to 20 postpartum was decreased by about 13%. A similar decrease in the body weights of the litters from pinealectomized rats was observed. Placental lactogen was prepared from rat placentae and tested for its lactogenic effect in virgin rats. It proved to be highly active. Structure activity relationships of 18 tricyclic compounds were studied. Phenothiazine emerged as one of the most active ring systems. A similar study with 13 derivatives of butyrophenone showed two active substances in this group. (03 98 012)

A basic study of water transport through animal membranes is underway in Israel. The mechanism of vasopressin control of water excretion was studied in dogs, rats, humans and in the isolated toad bladder. The action of vasopressin in dogs was modified by infusing acid alkaline salt solutions, showing an increased responsiveness to acid infusion and a decrease with alkaline solutions. In human subjects, hypertensive patients required more vasopressin than normal subjects when subjected to a standard water excretion test. The isolated toad bladder was utilized to study the influence of pH and ionic

composition on vasopressin action. In contrast to the action in vivo in the dog, where vasopressin exerted a greater action in acid solutions, a stronger action was obtained in the more alkaline media in vitro. Optimal concentrations of calcium ions were established for maximal vasopressin action.
(03 31 038)

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FEED EFFICIENCY IN PRODUCTION OF MEAT, MILK AND EGGS
(RPA 311)

USDA and Cooperative Program

Location of Intramural Work	Commodity	Scientist
		Man-years FY 1968
Maryland (Beltsville)	Poultry	3.0
Florida	Beef cattle	0.3
Georgia	Beef cattle	0.4
Maryland (Beltsville)	Beef cattle	3.8
Oklahoma	Beef cattle	0.4
Virginia	Beef cattle	0.4
Maryland (Beltsville)	Dairy cattle	10.1
Tennessee	Dairy cattle	0.2
Utah	Dairy cattle	1.0
Maryland (Beltsville)	Swine	1.2
Maryland (Beltsville)	Sheep	0.6
New York	Sheep	0.1
Alaska	Other animals	0.1
New York	Other animals	0.3
Total		21.9

Intramural program is supplemented by extramural support representing
 (a) 0.2 SMY's at State Agricultural Experiment Stations,
 (b) 1.4 SMY's at other U.S. institutions, and
 (c) P.L. 480 funds in 4 countries representing \$347.1 thousand equivalent.

Problems and Objectives

In the last 20 years broiler feed efficiency increased 40% and further gains are possible. Similar gains in feed efficiency have not been made in the other classes of livestock. Feed is the largest cost item in livestock and poultry production. The total potential benefit or cost reduction possibility through new technology by 1980 approaches \$5 billion for poultry, beef and dairy cattle, swine, sheep and mink. A reasonable objective is to achieve 25 to 30% of this potential benefit during the next 10 years.

Major objectives of the research are to:

1. Reduce the feed required per pound of gain of chicken and turkey and per dozen eggs.
2. Increase feed efficiency in the ruminant, swine and mink.
3. Increase nonprotein nitrogen utilization, especially in the ruminant.
4. Reduce nutrient losses in crops at harvest, storage and feeding.
5. Increase the high lignin forage used to feed ruminants.

Progress - USDA and Cooperative Programs

A. Poultry

1. Energy and fatty acids in poultry nutrition. In experiments at Beltsville with various sources of protein in linoleic acid deficient diets, it was shown that factor(s) other than linoleic acid affected the performance of laying hens. Although the purified diets supplied all known nutritive requirements, including 3% linoleic acid, the performance did not equal that of a practical diet. A comparison of the growth rate of progeny of linoleic acid deficient and nondeficient dams showed that the non-deficient progeny gained weight more rapidly over a 16-week period than did deficient progeny. Semen from linoleic acid deficient male chickens showed a faster decrease in fertilizing capacity than did that from nondeficient males. Semen from deficient males showed a decrease of fertility below 90% on day 4 after insemination in contrast with day 9 for that from the non-deficient males. (03 29 017)

2. Factors affecting weight gain and feed efficiency. Management practices were developed at Beltsville for raising chicks from hatch to 5 weeks of age in individual cages. Daily live weights and feed consumption data were of little value because of abnormal variation from one day to the next. When the values were combined on a weekly basis, there was a lower correlation than expected between growth rate and feed consumption. The data obtained tentatively indicate that the growth rate between the 8th and 14th day of age was suitable for judging whether the chicken will be a fast or slow grower. The experiments were complicated by a high incidence

(20-30%) of leg disorder syndrome that was present in all tests. Efforts to correct this abnormality by changes in management, nutrition, and genetic background of chicks on experiment have been unsuccessful. (03 29 049)

3. Feedstuffs available in India. Thirty-eight feedstuffs comprising seeds, oilcakes, leaf meals, agricultural-industrial byproducts and animal products were analyzed for their proximate composition, gross energy values, acid insoluble ash, calcium and phosphorus. When chemical analysis showed the seed of Dhaincha, a legume extensively grown in India, to be rich in major nutrients, biological tests were run. However, these tests indicated that there were factor(s) present in the seed which resulted in poor growth and feed efficiency. Biological tests of several leaf meals showed that they supported adequate growth rate and feed conversion when fed at 15% level. Some animal and vegetable products, high in protein, were evaluated by biological and chemical methods for protein quality. The metabolizable energy values of ten feedstuffs were determined. (03 29 050)

4. Function of vitamin A. In cooperative research at Israel, it was found that a single oral dose of vitamin A palmitate was absorbed and stored in the liver to a greater extent on an adequate protein diet than on a 10% protein diet. The most important factor involved in malabsorption of the vitamin in protein deficient chicks is the poor hydrolysis of vitamin A ester in the intestine. Liver and kidney were highly active in hydrolysis of vitamin A acetate, but had only slight activity in hydrolysis of palmitate and in synthesis of vitamin A esters. The pancreas was highly active and the small intestine moderately active in hydrolysis of acetate and palmitate and synthesis of the vitamin esters. Protein restriction and supplementation of diet with 0.1% thiouracil had no effect on survival of chicks on a vitamin A deficient diet. Dietary thyroxine had no effect on survival of chicks on a vitamin A deficient diet. Dietary thyroxine had no effect with adequate protein, but shortened survival period of chicks when protein was restricted. Deposit of urates in the ureters was the most frequent pathological lesion found postmortem. (03 29 068)

B. Beef Cattle

1. Digestion and metabolism. At Gainesville, Florida, levels of urea (2, 4, 6% of diet) singly and in combination with fat and sodium chloride have been tested for regulation of a forage supplement intake by cattle. The 6% urea was a regulator of feed intake, but additional research is needed before recommendations can be made. (03 30 035) At Brooksville, Florida, results indicate that the growth rate of calves wintered on poor-quality hay was not improved by supplementation with a biuret-mineral supplement. Gains were improved, however, by supplementation with biuret plus corn or cottonseed meal. Consumption of the biuret-mineral supplement was a problem in the study. (03 30 032-2)

At Beltsville, research with ruminal microorganisms using the continuous culture device, pure cultures of Selenomonas ruminantium contained an average of 68% culturable cells when substrate was added twice daily as opposed to 55% when the same amount of substrate was added on a continuous basis. S. ruminantium required 12 μM of nitrogen per ml for optimal growth as a batch culture in chemically defined medium which contained 0.33% cellobiose. Alanine (4.5 $\mu\text{M}/\text{ml}$) was detected as a metabolite in the medium after growth.

In other continuous culture studies benzyl viologen was shown to shift fermentation toward butyric acid production when a roughage substrate was added and to propionic acid when a concentrate substrate was added. Attempts to grow a mixed population of rumen microbes in continuous culture with a diet which contained little nitrogen was enhanced if the culture was sparged with nitrogen gas, or compressed air compared to a culture sparged with helium. However, if a substrate containing urea was supplied to the microbes and nitrogen gas was sparged into the cultures, the nitrogen provided no beneficial effect upon bacterial numbers or fermentation activity compared to a culture sparged with helium. The average ruminal protozoal concentrations were slightly higher for bulls and heifers than for steers fed a roughage-concentrate ration ad libitum. Rumen protozoal numbers did not appear to be reduced when sheep were dosed with acetyl hydroxamic acid, a urease inhibitor. (03 30 046)

In nitrogen metabolism studies at Beltsville, steers adapted to urea as the sole source of dietary nitrogen in a purified diet were essentially unable to degrade biuret to ammonia, but degradation of uric acid to ammonia occurred to a greater extent. When steers were fed these NPN sources for 21 days, ruminal degradation to ammonia was more pronounced, especially with uric acid. Ruminal infusion studies indicated that depressed salivary flow of steers is inversely related to ruminal ammonium concentrations. Infusions of alkaline buffers or urea plus acetic acid did not influence salivary flow.

Nitrogen balance studies indicated that steers fed urea (50% of dietary N) were adapted after 7 days whereas steers fed biuret required 21 days to adapt to the NPN sources when being fed an 85% roughage diet. Stilbestrol did not influence nitrogen utilization or adaptation time. Nitrogen retention was slightly less when the steers were fed the biuret diet. In a growth study, animal performance was similar when the diets were fed on an ad libitum basis, but when the steers were fed twice daily, the biuret diet resulted in superior animal performance. Producing urea or ammonia toxicity by ruminal infusions caused dramatic changes in the EKG patterns of steers which were not apparent in animals receiving urea as the only source of dietary nitrogen for 2 years. There was no detectable interaction between pelleting a high-roughage diet and level of intake as related to salivary flow rate in steers. (03 30 032-1)

In nitrogen metabolism work at Front Royal, Virginia, 24 pregnant beef cows in confinement were fed corn or apple pomace silage with one of four protein supplements: cottonseed meal, urea, biuret, or urea plus biuret. Protein and energy were equalized for each lot. Calves were stillborn from the nine cows receiving pomace and nonprotein nitrogen (NPN). Their birth weights averaged 29 lbs., less than half the normal value. In contrast, only one of the remaining 15 calves was stillborn and all had normal birth weights. Whether the stillbirths were caused by pesticide residues, excessive NPN with pomace, or synergistic effects not yet understood will be examined in more detail in the coming year.

In further work at Beltsville, diethylstilbestrol implantation of finishing steers fed corn-based diets resulted in a reduction in the concentration of the essential amino acids, except for methionine and histidine which increased. Urea and serine concentrations were also depressed while the concentration of hydroxyproline was markedly increased. Acetohydroxamic acid delays the degradation of urea to ammonia as shown by reduced rumen ammonia concentrations shortly after feeding. Feeding 7.5 gm before feeding increased nitrogen retention from 0.7 gm to 2.0 gm daily. Supplementing an orchardgrass pasture with molasses plus urea or corn plus fat altered ruminal pH, ammonia, and VFA. Highest total gain for 112 days without supplement was 208 kg/ha; when molasses plus urea was fed, 379 kg/ha; and when corn plus fat was fed, 701 kg/ha.

Steer calves were successfully finished on a pelleted all-roughage diet containing 98.5% alfalfa hay during a 168-day study. Animal performance and carcass merit of these steers were similar to that of steers fed the all-roughage diet for the first half of the study and later switched to an all-concentrate diet the last half of the study or a vice versa management regime. Feedlot performance and carcass quality were the best with calves fed the all-concentrate diet during the complete study.

Steer feeding and drinking patterns in red, green or blue light environments were similar to those of steers in a white light environment and were reversed when the light:dark cycle was reversed. (03 30 027-1)

Three experiments with rats have been performed in Israel to evaluate compensatory growth in mammals. Under the conditions of these experiments, the results indicate that following a period of rather severe caloric restriction, rats undergo compensatory growth, reach the same weight as freely fed controls in the same length of time, and achieve this on a smaller total amount of feed. Meal-eating promoted compensatory growth more than other methods, presumably by increasing the feed capacity of the animals. Females performed consistently better than males, relative to the control, but full compensation has been demonstrated in both sexes. In order to obtain satisfactory compensatory growth in males, they must not be underfed before 35 days of age. The experiments with rats demonstrate both the

feasibility and complexity of the application of underfeeding in order to promote subsequent and overall growth and feed efficiency. The results require a reappraisal of the view that animals utilize feed most efficiently when growth is continuous. (03 30 043)

2. Nutritive value of feeds and forages. At El Reno, Oklahoma, six methods of processing milo--coarse grinding, fine grinding, dry rolling, reconstituting-rolling, reconstituting-grinding, and steam process-flaking--were compared in a high concentrate ration. All processing methods significantly improved feed efficiency compared to coarse grinding, with greatest improvements noted for reconstituting-rolling and steam process-flaking. Steam process-flaking resulted in the fastest rate of gain; gains of the other processed grains were similar. Feed intake was significantly lower on reconstituted-rolled milo, reflecting more efficient utilization since rate of gain was not depressed. Carcass merit and dressing percentage were not affected by processing method. (03 30 027-2)

At Tifton, Georgia, steers fed dehydrated and pelleted bahiagrass or Coastal Bermudagrass harvested at 4 or 8 weeks of age gained most rapidly when fed the 4-week bahia grass and most slowly when fed the 8-week Coastal Bermudagrass. At both ages, the bahia grass was higher in protein, lower in crude fiber and cell walls than the Coastal Bermudagrass. Steers grazing Gahi or a late maturing millet (Tiflate) gained equally well. The Tiflate millet offers the possibility of a longer grazing season. Coastal Bermudagrass pellets, cottonseed hulls, ground peanut hulls, and oyster shell were evaluated as a source of roughage as a part of a shelled corn ration. All sources were satisfactory when utilized under good management conditions. (03 30 037)

At Davis, California, steam-pressure (1.5 min. at 50 psi) processing of milo improved feed efficiency of feedlot steers by 8% whether it was rolled or ground. Less improvement was noted with barley. (03 30 033)

Trace elements measured in grasses were greatest at early harvest and diminished with maturity while with alfalfa the stage of development had no effect in the trace element content. (03 30 044)

C. Dairy Cattle

1. Energy metabolism. Calorimetric studies involving the use of a gradient layer calorimeter and closed circuit respiration chambers were carried out at Beltsville to determine the validity of factors used to compute the heat production of ruminants from respiratory exchange data. In some instances unexplainable discrepancies as great as 10% or more occurred, but no consistent differences were shown. There was no statistically significant difference between heat production measured directly and that which was computed with the equation: $\text{Heat production} = 3.866 \text{ O}_2 + 1.200 \text{ CO}_2$

-0.518 CH₄ - 1.431 N. The within and between animal variations in total heat production were greater than the instrumental errors by either method. Further progress was made in automating the open circuit respiration chambers for cattle, including the revision of computer programs to facilitate compilation of all past energy balance data. Additional equations and error checks were incorporated into the routine programs. Previous energy balance experiments with lactating cows were summarized, and recommendations were made to use net energy for lactation (NE_l), based on the caloric value of milk, to calculate rations for dairy cows. (03 31 025)

In preliminary work, an experimental basal ration was formulated and tested for adequacy in regard to vitamin and mineral content, especially with respect to the trace minerals shown in recent years to be required by the rat - zinc, copper, chromium, selenium and molybdenum. The ration was also tested for any possible deleterious effects of the inclusion of BHA (Butylated Hydroxy Anisole) at a level of 0.003% as a preservative for experimental fats; no such effects were observed. An experiment was initiated and is currently in progress in which rats are being fed in the tested basal ration equicaloric amounts of safflower oil (a fat containing a large proportion of diunsaturated fatty acids), peanut oil (a fat containing a large proportion of monosaturated fatty acids), or butterfat (a fat containing a large proportion of saturated fatty acids). These fats are being compared with each other and with a low-fat carbohydrate control ration. At the conclusion of the feeding period, the rats will be slaughtered and analyzed to determine the comparative effects of the various fats upon dietary energy utilization. (03 31 053)

At Yugoslavia, preliminary investigations of the effects of ration composition on the rumen microflora, production and absorption of volatile fatty acids and lactic acid from the rumen have begun. Catheters have been inserted in the portal vein of cows that will be used in the absorption studies. Gas chromatographic methods for analyzing rumen and blood samples for volatile fatty acids have been worked out, and progress has been made using this technique for the analysis of lactic acid. Rations containing 90, 80, 60, and 40% of the ration as concentrates were fed to lactating dairy cows, and the cows producing more than 20 kg milk daily were unable to consume sufficient quantities of the ration containing 50% grass silage to meet their estimated energy requirements. Neither milk fat test nor persistency of lactation was affected by ration composition, but the results were quite variable. Digestibility studies were made by means of Cr₂O₃ because of technical problems in carrying out quantitative total collection of feces. (03 31 074)

2. Biochemistry and rumen microbiology. Further progress was made at Beltsville in characterizing chemical components in forages that limit nutritive value. A basis for a method for determination of cutin has been established, and it appears that cutin is an important factor limiting the

nutritive value of the fibrous fraction of concentrates. A procedure has been improved for the characterization of plant metabolic silica. An ensiling process with sodium chlorite appears to remove lignin and has resulted in greatly increased in vitro digestibility. Much information has been collected on the influences of environment on the composition and nutritive value of forage. Temperature is particularly important. Growth requirements of important rumen bacteria have further demonstrated the requirement and metabolism of CO₂. Bacterial efficiency remains an important question. Knowledge gained in the above studies will be indispensable in further improving feed quality and efficiency of the dairy cow. (03 31 022)

In the continuing study of ruminal synthesis of vitamin B₁₂, 5,6-dimethylbenzimidazolyl cobamide (vitamin B₁₂) constituted about 19 to 20% on the average, while an animal-active analog, 5-hydroxybenzimidazolyl cobamide (vitamin B₁₂-factor III) made up about 14%. Of the microbiologically active analogs, 2-methyladenyl cobamide (Factor A) was present in the largest amount (38 to 51%). Adenylcobamide (pseudo-vitamin B₁₂) made up about 10% of the total activity (for E. coli) in samples from cows fed silage or hay, but less than 1% of the activity in samples from cows fed hay-grain. About 8% cobinamide (Factor B) was present in samples from silage-fed cows, but less than 1% in samples from cows on the other rations. An unidentified slightly electrophoretically positive analog (about 8%) was generally present. Small amounts (1 to 2%) of what appeared to be Factor C and Factor E also occurred. Of 7 pure strains of rumen microorganisms tested that synthesized vitamin B₁₂ or its analogs, all produced vitamin B₁₂ or 5-hydroxybenzimidazolyl cobamide (15 to 40% of total activity). Five of the strains synthesized cobinamide (7 to 53%), four formed 2-methyladenyl cobamide (32 to 77%), while three produced adenylcobamide (6 to 16%). In addition, four strains synthesized an unidentified slightly positive analog (6 to 26%), while three produced what was apparently Factor C (8 to 19%). (03 31 054)

In the study of vitamin B₁₂ protein complexes in Poland, seven strains of propionibacteria, representing three species, were experimentally selected for study. A light-sensitive corrinoid complex was isolated in the dark from Propionibacterium freudenreichii -3 cells. Electrophoresis studies indicated that 55% of the corrinoids in the complex was bound to polypeptide. Comparison of this complex with one previously isolated in a similar manner from P. shermanii-1 showed good agreement in an absorption spectra and in reaction to cyanolysis and to photolysis, and similarities in electrophoretic mobility. Chromatographic studies, however, indicated less heterogeneity of the P. freudenreichii complex. The ratio of polypeptide to corrinoid was significantly less in the latter complex. The amino acid compositions of the polypeptide portions of the two complexes were qualitatively identical. They were characterized by the absence of cystine, the presence of only a trace of tyrosine and the predominance of

of glutamic acid, proline and glycine among the amino acid residues. The P. freudenreichii complex contained twice as much lysine. Evidence was obtained for the presence of methyl-B₁₂ in samples of the complexes from both organisms. (03 31 024)

Systematic enzymatic investigations were carried out in Yugoslavia to determine the most appropriate method and reaction mixture for determination of enzymatic activity in the epithelium of the rumen reticulum and omasum. The presence and activity of the following enzymes in these tissues was measured: dehydrogenase of glutamic acid, glutaminase I, glutamic-oxaloacetic transaminase, glutamic-pyruvic transaminase, hexokinase, aldolase and dehydrogenase of glucose-6-phosphate. The results substantiate the concept that the epithelium of the rumen contains highly active enzyme systems for converting ammonia to less toxic forms before entrance into the blood stream. (03 31 051)

3. Improve quality, utilization and value of silage. At Beltsville, the effects of forage particle size and lignification on the utilization of forages was studied using sheep. Cell wall digestibility declined with decreased particle size fed and with cell walls containing a greater proportion of lignin. The rate of passage through the digestive tract appears to be independent of particle sizes less than 200 microns. Extent of cell wall digestion was directly related to the percent size reduction upon passage through the total digestive tract. Experiments involving various forage preservation procedures demonstrated that (1) the relative feeding value of direct cut alfalfa silage and hay is dependent on the maturity of the crop when harvested, (2) wilting of oat silage may be substituted for the addition of 10% corn meal to the direct cut silage without lowering feeding value, (3) sealing a bunker silo with liquid molasses results in low feed recovery (80%) and no improvement in the value of the silage, (4) a plastic sheet vacuum stack is no more efficient than usual plastic sealing in a bunker but is more inconvenient, and that (5) quality of laboratory silage developed in sealed plastic bags depends on the thickness of the bags used as well as the storage period. (03 31 030)

Direct comparisons of untreated, unwilted silage (U) vs. wilted silage (F) treated with 0.5% of 90% formic acid were made using alfalfa (A) and a sorghum-sudan hybrid, Sudax SX-11 (S). The Kcal DE consumed per day per kg of metabolic size were: AF, 281; AU, 280; SF, 170; and SU, 173. The grams of daily gain were: AF, 757; AU, 541; SF, 184; and SU, -2. The very poor gain on the hybrid was a result of a low protein content (8.75% CP). Supplementing with protein increased the gains: SF, 508 and SU, 422. The digestibility of energy was not increased by formic acid in these experiments. The gain per unit of DE was greater for the animals fed formic acid silage. The last five untreated, unwilted silages produced a mean daily gain of 313 g as compared to 668 g from five formic acid treated, wilted silages. (03 31 018)

Four silages were prepared and fed to groups of milking cows. One corn variety (DeKalb XL 45) has a characteristically high ear:stalk ratio, the other variety (Pioneer 1097) has a low ear:stalk ratio typical of silage varieties. One silage from each variety was made after removing the ears and one from each variety was made in the usual manner. These treatments were selected to provide observations on the relative importance of ear content and stalk quality to silage consumption and animal performance. The same varieties were planted in small plots to allow harvesting at 6 maturities separated by 10 days each. Results of this work are not yet available, but will be included in a final report of the associated Research Contract. (03 31 034)

4. Concentrate feeding. At Ithaca, New York, 50 cows were assigned initially to this project for a period covering 3 lactations. An additional 8 cows have since been assigned as replacements. Total summarization of data and results is being deferred until all lactations have been completed. Only 1 cow of the original 10 assigned to the all corn silage and grain ration has survived three complete lactations. Eight of these cows died from a variety of causes during the first two months of the second or third lactation. No explanation of the difficulty is evident at present. Preliminary interpretation of the data available indicates that restriction of forage feeding and replacement with higher grain levels does not result in improved production levels. (03 31 027)

At Logan, Utah, the 3rd and 4th of 6 sets of 32 lactations each was completed, the 5th continued and the 6th started. To a hay diet, grain was added at 4 rates averaging (for sets 3 & 4) about 1, 1-3/4, 2-1/2, and 3 tons per 305 days. Milk (4% FCM) increased about 1,000 lb. with each grain rate increase except for last increment, for which there was a variable and questionable response. Daily hay consumed averaged 38.7, 37.0, 33.3 and 28.9 lb. with grain intakes of 6.5, 10.8, 17.1 and 19.4 lb. Two grain mixes were fed to paired cows at each grain rate. A simple mix was compared with a 14% protein mix. Two sets of cows averaged grain intakes of 13.2 and 13.6 lb., hay intakes of 34.2 and 34.8 lb. and FCM produced 48.6 and 50.9 lb. Body weights were not affected by any treatments. Individual variations necessitate summary evaluation only after all lactations are completed, although some trends indicate the direction and degree of response. Balance trials with sheep and heifers compared various ratios of hay and grain corresponding generally with the 4 ratios fed to lactating cows. (03 31 033)

5. Improving quality, utilization and value of hay. Ranger, DuPuits and Lahontan varieties of alfalfa were harvested at Logan, Utah, from two replicates each during the summer of 1966. Plots were harvested 4 and 3 times respectively on June 1, July 12, August 15 and October 10; and June 13, July 26 and September 29. These hays were evaluated in intake-metabolism trials with sheep and in intake trials with heifers. Methods of evaluating forage with acid detergent fiber and lignin, cell wall constituents and

in vitro digestion will be compared to the in vivo results. The average dry matter digestibilities from the 4 times plots were 69.5, 64.9, 65.3 and 70.3, respectively for the various crops and for the 3 times plots were 64.7, 61.0, and 64.9. The average dry matter digestibilities for the Ranger, DuPuits and Lahontan varieties were 66.5, 65.7, and 65.2, respectively. Intake values are expressed in terms of a daily intake of dry matter equivalent to a percentage of body weight. The percentage intakes with wether lambs were 3.07, 2.43, 2.78, and 3.04 for the 4 times and 3.00, 2.66, and 2.82 for the 3 times, respectively. Intake trials with 12-14 month old heifers resulted in values of 2.38, 1.88, 2.09, and 2.61 and 2.19, 1.60 and 2.19. Average intake values for the three varieties were very similar. (03 31 032)

6. Genetics of feed utilization. Two studies were initiated at Beltsville to evaluate the effectiveness of a feeding regime in which the forage and concentrates were combined into a complete feed. Control groups were established utilizing the conventional component feeding system as a comparison. The basic forages utilized were alfalfa hay and corn silage. In both studies, the ratios were evaluated during the early stage of lactation (0-120 days) in an effort to determine if such a system can be utilized to support high levels of production during this period. Preliminary results indicated that the cows fed complete feed silage ration produced less than the control group during the first 120 days, and that these differences were probably associated with difference in dry matter consumption. In the complete feed hay study, the level of milk yield was similar in both groups. However, on an FCM basis, the complete feed group exceeded the component feed group by approximately 1,000 lb. These differences were associated with the average percent butterfat and dry matter consumption. (03 31 058)

In a previous study in which 12 month old heifers from each of three mating systems were fed hay ad libitum and 30 lb. of grain daily for 120 days indicated differences among groups and sires within groups for total gain, average daily gain and therms consumed. The Swiss crosses ranked first, followed by outcrosses, linebreds and Ayrshire crosses. There were no differences among groups in efficiency. Apparently the differences in gain are a result in appetite differences. In an effort to verify the foregoing conclusions, a study was initiated in which a pelleted ration was fed at the rate of 2.0 lb. per 100 lb. of body weight twice per day. The preliminary results show an average daily gain of 1.50, 1.50, 1.64, 1.60 and 1.51 for the outcrosses, linebreds, Swiss crosses, Ayrshire crosses and back crosses, respectively. The corresponding values for efficiency of gain were .160, .159, .166, .159 and .163. An analysis of variance indicated there were no differences among the mating system group in rate of gain, therms consumed or efficiency of gain. (03 31 059)

7. Growth and performance responses. In a comparison of growth and carcass traits for sons of AI sires with high and low milk production proofs at Madison, Wisconsin, the sons of the 4 "high" sires yielded more pounds of trimmed major wholesale and retort cuts than did the sons of the "low" sires. There were no differences between the two groups in daily gain from 4 months to final shrunk weight (approximately 1,000 lb.), feed efficiency, carcass grade, palatability, estimated percent of carcass fat, lean or bone and yield of minor wholesale cuts. The average daily gain from 4 months to slaughter weight was 2.7 lb. Sire group means varied from 2.5 to 3.0, while individual steers ranged from 2.2 to 3.5 lb. per day. About 5 lb. of TDN was required per pound of gain. (03 31 005)

In nutritional physiology work in India, it has been found that calves can be successfully reared between the ages of 7 and 24 months with rations using good quality home grown roughages to replace approximately 60% of the concentrate level previously considered necessary. Growth rate, blood pictures and physiological reactions were unaffected by the substitution of fodder for concentrate at this level. Lactating cows of Red Sindhi, Sahiwal and Tharparkar breeds were able to maintain production up to 10 kg per day on green berseem along. When nonleguminous fodders were used, it was necessary to feed concentrates at a level to meet the energy requirement for milk. Total DCP requirements during the dry period could be provided in 10 to 12 kg of green berseem. The energy requirements were met by supplementing berseem with 2 to 3 kg of oat straw. (03 31 046)

In Israel, the influence of feeding rate on growth characteristics of heifers continues to be as expected. Heifers fed on high energy rations are larger and heavier at all ages than those on low energy rations. Data are being collected on fertility and production for the various treatments. Studies of morphology and activity of thyroid glands in heifers indicate a positive relationship between plane of nutrition and thyroid activity. The comparisons between high level and standard feeding regime are continuing. In addition, three farms were surveyed to obtain additional information concerning the relationship between energy balance and reproductive rate, noted last year. These studies confirmed the observation that cows which were losing weight rapidly had lower reproductive rates than those in more favorable energy balance. (03 31 050)

The effects of different ratios of protein to energy in the rations of young fattening bulls was studied with 4 groups of animals in Yugoslavia. No significant differences in growth among groups were observed, thus the lower limits were not defined. It was found that the necessary g of digestible protein per SE was not more than 160 for animals 120-250 kg L.W.; 145 for 250-350 kg L.W.; and 130 for 350-450 kg L.W. Feeding milking cows at 120 vs. 100% of Frederiksen's feeding standards resulted in a small increase in milk production. Changes in feeding recommendation are expected to result from the completion of all experiments planned under the project. (03 31 052)

D. Swine

In mineral nutrition work at Beltsville, a retention study of zinc, calcium, and phosphorus in young barrows, fed a typical corn-soybean meal diet, was conducted to obtain more information on the interrelationship of these three minerals. Weight of the pig influenced both feed consumption and calcium, phosphorus, and zinc intake, excretion, and retention on a unit of body weight basis. The level of dietary calcium influenced calcium intake, excretion, and retention but not zinc retention. Level of zinc in the diet influenced zinc intake and excretion but not retention. On a per-pig per-day basis, phosphorus and calcium retention were affected by calcium intake and weight of the pig. Zinc supplementation increased zinc content of liver and kidneys and alkaline phosphatase activity in the serum and small intestine. Results indicate that efficient, fast-growing pigs may require more minerals per unit of feed than the levels that are currently recommended. (03 32 019)

In the study of nutrition on lines of swine selected for high and low backfat thickness, pigs from lines selected for maximum and minimum backfat within the Yorkshire and Duroc breeds were used to measure the effect of difference in type on response to nutritional variables. A comparison of 12 and 20% levels of dietary protein showed that carcasses of pigs fed the 20% protein diet had significantly more lean than did those from pigs fed 12% protein. There was also a significant diet x line (degree of fatness) interaction. Within the low-fat line carcasses of pigs fed 20% protein contained 36% more lean than did those from pigs fed 12%, while in the high-fat line there was only an 8% increase. There were no significant diet effects on weight of carcass fat. (03 32 020)

In the continued study of improved cottonseed meals, data show that lysine supplementation increased appetite and feed efficiency but had no effect on toxicity. The addition of iron as ferrous sulfate or fumerate supported normal growth and reduced mortalities 50%. Replacement of 25% of cottonseed meal with SBM reduced mortality 33.3%, and replacement of 50% or 75% completely eliminated toxic symptoms and produced gains slightly better than those obtained from straight SBM. The use of gossypol-free cottonseed meal eliminated mortalities and supported growth equivalent to that for SBM. The results indicate that methods are available for the safe use of cottonseed meal as a protein supplement for swine. Their feasibility depends on prevailing economic conditions. (03 32 021)

Work on the investigation of amino acid composition of feedstuffs for pigs continued in Yugoslavia. In addition to those made on the amino acid analyzer, tryptophan was determined by enzymatic hydrolysis. Plasma amino acids of young pigs on a protein-free diet were studied as well as those from older pigs on growing rations. Large scale feeding experiments under

farm conditions are in progress to establish and check the most desirable ration formulations developed in this study. (03 32 028)

E. Sheep and Goats

1. Utilization of forages, pellets and protein supplements. Crownvetch has been grazed at 3 intensities by sheep for 2 years at Beltsville. Sheep performance has been satisfactory at all grazing intensities and yield of liveweight gain has been greatest at the highest intensity. However, reduction in vigor of the crownvetch stand has resulted from the highest grazing intensity. The reduction in stand vigor has resulted in a greater population of grasses, and a decrease in vigor, but not of number of Crownvetch plants. (03 33 011)

Observations have been made on sheep at Beltsville, since 1963, that have received (1) limited amounts of a mixture of 60% ground alfalfa hay, 30% ground barley and 10% molasses; (2) limited amounts of alfalfa hay pellets; (3) the alfalfa-barley-molasses mixture ad libitum; and (4) alfalfa hay pellets ad libitum. The lot self-fed on ground feed has been heaviest over the years followed by the lot self-fed on pellets. The lot fed limited amounts of pellets has averaged heavier than the lot on limited ground feed except for the most recent year. Livability over the years has been highest for the lot self-fed on ground feed followed by the lot fed limited amounts of ground feed, and the lot fed limited amounts of pellets while the lot self-fed on pellets was lowest. (03 33 009)

In Israel, starch supplementation supplied by corn grain, was rapidly lost from ruminal ingesta and the rate was independent of the source of dietary protein when alfalfa and soybean meal were compared. A procedure has been adapted for the separation of low molecular weight polypeptides in rumen ingesta and for the qualitative estimation of the amino acid content of these polypeptides. There was an appreciable dietary effect on the concentration of low molecular weight peptides. The concentration was least on soybean meal diets, greater on a vetch-oat hay diet and greatest on a mixed diet. Methionine occurred at very low levels in the free form in rumen fluid, but in considerable concentrations in the short chained peptides. (03 33 021)

2. Productivity of pastures grazed by beef and sheep. Results of 4 grazing seasons showed that the average daily gain (ADG) and live-weight gain per hectare (LG/Ha) for steers and sheep were affected ($P < 0.01$) by year. The growth for steers was not affected by the ratio of steers to sheep, but this ratio did affect ($P < 0.01$) the ADG and LG/Ha of sheep. Sheep gains and total production were highest at the lowest stocking rate and at a ratio of one steer to five sheep. (03 33 015)

3. Nutritional requirements. Preliminary results indicate that larger ewes consumed more feed than smaller ewes, but lambs from larger ewes required less feed to reach market weight. Lambs sired by smaller rams required more feed than those sired by larger rams. Lambs of larger parents produced leaner carcasses than those of smaller parents. (03 33 029)

4. Meat and milk potentialities in Indian goats. Jamnapari and Barbari does maintained on high and medium levels of TDN, irrespective of protein levels, attained higher body weights, produced more kids and yielded more milk than does maintained on low levels of TDN. High, medium and low levels equal 125%, 100% and 75% of the recommended allowances for sheep. (03 34 011)

F. Fur Animals

1. Diets and nutritional requirements of mink. During the reproduction season of 1968 at Ithaca, New York, a study was conducted on 21 female pastel mink and their progeny to determine the effects of feeding cooked Great Lakes Alewives at a 20% level in the diet. Reproduction was poorer than normal in mink receiving the Alewives due to higher kit mortality and kit growth was poorer from birth to 6 weeks of age. Analyses are currently under way to determine possible pesticide contents of the fish. Fat has been extracted from samples of the fish and will be fed to rats to determine possible harmful effects from this source. (03 34 006-1)

In order to develop nutritionally adequate and economically practical rations for mink, it is necessary that the nutrient requirements be known. This is particularly important since the development of diets containing no fresh animal products could reduce the cost of mink feed ingredients by one-half. During the summer and fall of 1967, 80 mink kits were fed diets deficient in vitamins D and K, inositol, biotin, choline and paraaminobenzoic acid (PABA). Biotin, choline and PABA have been implicated in the greying of fur in other species and thus marginal deficiencies could have practical importance in the development of marketable mink pelts. There were no clinically observable lesions of deficiency except in the groups deficient in biotin. These mink developed "spectacle" eyes, crusty feet, a dermatitis of the foot pads, and the underfur was altered to a greyish-white color. Further studies are being conducted to determine the influence of rancid fats upon the requirement of the mink for biotin. (03 34 007)

The requirements of mink for liver in the diet during gestation, parturition, lactation and early kit growth have not been established. The determination of the liver nutrients that are required by mink would be important in the development of dry diets and should lead to a reduction in feed costs. Of 32 female mink receiving a typical mink diet containing 5% liver, 26 females whelped and had 135 kits that were alive 14 days after birth. Of 29 females receiving a ration similar to the control but with no fresh liver and all known vitamins supplemented above levels believed required, one female whelped and there were no kits alive 14 days after birth. The non-producing mink in the no liver group were pregnant, but the embryos died and were resorbed. Blood samples did not indicate any evidence of anemia, and liver and blood levels of vitamin A were determined to be adequate. Currently feed samples of both diets are being analyzed to determine the differences between the two diets. (03 34 008)

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None

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None

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D. Swine

None

E. Sheep and Goats

1. Utilization of forages, pellets and protein supplements

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2. Productivity of pastures grazed by beef and sheep

None

3. Nutritional requirements

None

4. Meat and milk potentialities in Indian goats

None

F. Fur Animals

1. Diets and nutritional requirements of mink

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ENVIRONMENTAL STRESS IN PRODUCTION OF LIVESTOCK AND POULTRY
(RPA 312)

USDA and Cooperative Program

Location of Intramural Work	Commodity	Scientist
		Man-years FY 1968
Indiana	Poultry	0.2
Mississippi	Poultry	1.4
Florida	Beef cattle	0.7
Louisiana	Beef cattle	0.3
Louisiana	Dairy cattle	1.0
Maryland (Beltsville)	Dairy cattle	0.1
Total		3.7

Intramural program is supplemented by extramural support representing
(a) 0.5 SMY's at State Agricultural Experiment Stations,
(b) 0 SMY's at other U.S. institutions, and
(c) P.L. 480 funds in 1 country representing \$11.5 thousand equivalent.

Problems and Objectives

The total investment in farm buildings in 1964, excluding operator dwellings, was estimated at \$14.6 billion. Most of these facilities are for livestock, but, in spite of this large investment, stresses from the effects of climate, handling, and other environmental causes decrease productivity. Reducing these effects through production practices could result in potential benefits in livestock and poultry of nearly \$900 million annually by 1980. Extremes in temperature, humidity, and air movement lead to poor feed efficiency, throw animals off feed, reduce resistance to disease, and in extreme cases cause death losses.

Major objectives of the research are to:

1. Increase growth rate in broilers and turkeys and increase egg production by improving the environment and stress-related production practices.
2. Improve the overall production efficiency of cattle, sheep, and swine during hot seasons through improved production practices.

Progress - USDA and Cooperative Programs

A. Poultry

1. Hormones and stress. Daily blood samples were taken from 4-week old Athens Randombred males, which were receiving slow-release forms of cortisol and ACTH over a 5-day period. Significantly lower total white blood cell counts were observed after two days of injection with either 2 U.S.P. units of ACTH or 0.5 mg. of cortisol/100 g. body wt./day. The leucopenia was primarily a lymphopenia with a transient reduction in basophils occurring on the second day of treatment. A significant heterophilia occurred with 0.5 mg of cortisol after three days. The importance of these results along with those observed previously with blood chemistry, lies in the difference in the timing of response by the measured variables. Hyperlipemia, notably a hypercholesteremia, occurs before the lymphocyte depression and the heterophilia occurs last.

To investigate the hypercalcemia previously shown to result from high levels of cortisol, 1.5 or 3.0 mg of cortisol/100 g. body wt./day or 8 U.S.P. units of ACTH were administered daily to 2 1/2-week old White Rock females. Both levels of cortisol increased plasma calcium within 1 week and ACTH increased it within 2 weeks after injections began. Bone measurements indicated that percentage of fat-free bone and percentage ash were significantly reduced by cortisol within 2 weeks. Histological evidence of reduced bone calcification was also observed. Thus, stress-related bone deformities in chickens might be related to hypersecretion of endogenous adrenal corticoids. (03 29 043)

2. Temperature and density stress. Two replicates of the line being selected for resistance of 14-day embryos to high temperature have been initiated at Indiana. The first replicate of a line resistant to low 14-day embryonic temperature has also been initiated. Heritability estimates from the three systems, based on 50 sires in each line, are .70, 1.2, and .39, respectively. Progeny of the first selected generation are now being tested for body weight, egg production and egg quality traits. Equipment has also been attained to measure oxygen consumption in the stressed and non-stressed embryos and selected and non-selected lines and to determine the exact temperature to which the embryo is subjected during stress. If the resistance to heat stress is genetically correlated with body weight or production traits, post-hatching, heat resistance, liveability or other economic traits, it will be of great value insofar as selection for these traits might be greatly simplified. (03 29 092)

At State College, Mississippi, the theory that "stress" in the absence of an infectious organism will result in broiler condemnation and that "stress" in the presence of an infectious organism will result in more condemnations has been tested using temperature as the stressing factor. Temperature extremes of both heat and cold were used on birds ranging from 1 day to 5 weeks of age. Birds with and without Mycoplasma gallisepticum infection were used. A total of 14 experiments were conducted. Results show that temperature, under the conditions of these experiments, was not a consistent cause of increased broiler condemnations.

During the studies to determine effects of low temperatures on broilers, it was observed that groups composed of small numbers of chicks could withstand exposure to low temperatures with no brooding heat. As anticipated, when this was tried with larger groups, mortality increased primarily due to piling and smothering of the chicks. When body weights for chicks brooded with reduced heat were not more than 13% lower at 3 weeks than for those conventionally brooded, the body weight differences were eliminated by 8 weeks. (03 029 087)

At Madrid, Spain, twenty generations of selection in *Tribolium* have been completed. Based on analyses of data from thirteen generations, it seems apparent that the population selected under normal conditions performs better in normal and stress environments than populations selected under stress conditions and is less variable. The results indicate that the contention that selection should be practiced under the same conditions in which the selected population is expected to perform may in fact be erroneous and that the most effective environment for selection, in fact, varies with species. (03 29 051)

At State College, Mississippi, it has been found that considerable discrepancy exists in the literature concerning density effects on broiler performance. The theory that these discrepancies are due not only to social but also environmental effects and the interaction of the two was tested using 9,120 commercial broilers in four experiments. Results show that when broilers are reared for the last 5 weeks at temperatures above approximately 80°F for one-half the time or more, body weight gain is significantly reduced when compared to temperatures below 80°F. A significant density effect on body weight gain is evident when broilers are reared for the last 5 weeks at temperatures below approximately 70°F. With temperatures between approximately 70° and 100°F, density effect on body weight gain is eliminated at the 5% level of probability when density levels of 0.70 and 1.00 square foot per bird were compared. There is a trend for better feed efficiency at higher temperatures, but mortality and condemnation were not significantly affected by temperature or density level utilized in these studies. (03 29 088)

3. Physiological response to stress. At State College, Mississippi, a telemetry technique was used to record body temperature of broiler chicks to determine if the lowering of body temperature for short periods is a stress that results in higher condemnations, mortality, or reduced body weight gain. In one experiment, reducing the body temperature of broilers at 1, 8, 15, and 22 days of age to 76.0°, 78.8°, 91.6°, and 103.2°F, respectively, had no significant effect on 8-week body weight, mortality, or condemnation when compared to the controls. When the body temperature dropped below 80°F, chicks became comatose. In another experiment, two groups of females, 1 day and 7 days of age, were subjected to a 25°F ambient temperature until comas developed. In both experiments, the chicks were removed from the cold chamber and placed with the control group as soon as the coma developed. This had no significant effect on 8-week body weight, mortality, or condemnation. (03 29 089)

A mathematical model was developed to represent a broiler in its thermal environment for the purpose of making parametric studies of the effects of environmental conditions on the thermal energy losses of a broiler. Coalition of theretical aspects of thermodynamics and heat transfer and experimental results which appear in the literature have resulted in a simplified mathematical representation of the steady state conditions with given assumptions on respiration rates. The effects of dry-bulb temperature, relative humidity, bird body weight, feather position, ventilation air velocity over the bird, respiration rate, and huddling have been studied using parametric analyses of the mathematical model with the use of a high-speed digital computer. Extrapolations and cross-plotting of the resultant calculations have produced a predicted temperature range for satisfactory bird growth. Further work should produce results which could conceivably be employed in optimizing the ration for maximum gain at minimum cost for given bird size and anticipated environmental conditions. (03 29 091)

In the study of nutrition and environmental influences on broiler losses caused by disease, commercial broiler chicks in two experiments were infected by Mycoplasma gallisepticum and subjected to a fluctuating diurnal temperature of 5° to 21.7°C between 4 and 8 weeks of age. A high-energy ration containing 6-1/2% poultry oil was compared to a low-energy ration containing 1-1/2% poultry oil. Birds receiving the high-energy ration had a significantly greater gain in body weight and significantly greater feed efficiency than birds receiving the low-energy ration. (03 29 086)

B. Beef Cattle

1. Selection for adaptability. The performance of progeny from three top-cross sire and dam lines and an industry herd of beef cattle were evaluated at Tucson, Arizona. The four-year period of data showed that the dam line had a greater influence on preweaning growth than did the sire line, but the sire line influenced the birth weight and conformation score. Calves with the highest weaning weight by dam line had the lowest by sire line. The data suggest a negative relationship between maternal ability and genetic growth potential, since the maternal ability is more important in determining weaning weight performance than the genetic growth. (03 30 017)

The productive performance (percent calves weaned) of the Brahman and Santa Gertrudis cattle are lower than the Angus and Hereford herds in work at Brooksville, Florida. There was no specific combining ability demonstrated in this study and the data is being summarized for publication. (03 30 001)

In another study at Brooksville, the general appearance of the cattle indicate that the two lines are becoming more adapted to the Brooksville environment. The 1967 weaning performance of Miles City Control, Miles City Select, and Brooksville Line was: weaning percent, 75, 57, 78; slaughter grade, 8.6, 1.8, 9.3; 205-day weight, 365, 358, 407, respectively. (03 30 012-2)

At Jeanerette, Louisiana, there was considerable difference in fertility between the two selection herds. Cows bred to "local" bulls on pasture had a higher conception rate than females artificially bred to "outside" bulls. Progeny of cows in the "local" line gained slightly faster and were heavier at weaning than similar calves in the "outside" line. Summing up the post-weaning performance of bulls for the last three years reveals no difference in growth rate between the two selection lines. Slaughter data on the bulls are difficult to evaluate because numbers are too small. Observing the performance of the cattle to date, it appears that progeny from the "outside" line have more difficulty getting on feed, staying on full feed, gains fluctuate considerably, bloating seems a problem, and mortality of bulls on feed have been greater than for the "local"

line. Heifer progeny from the "outside" herd were bred for the first time in 1968. (03 30 002-2)

C. Dairy Cattle

1. Breeding for adaptability. At Jeanerette, Louisiana, the mean deviations of crossbreds from the age adjusted, 5-month rolling herd average of contemporary purebred Holsteins were: -86, -498, and -1,173 kg of milk for Holstein-sired crosses, Brown Swiss-sired crosses, and daughters of crossbred sires, respectively. No important differences were observed among breed groups for length of lactation, persistency of lactation and days carried calf. The purebred-sired crossbreds have shown 4-16% positive heterosis for milk yield, but this was not large enough for them to surpass the purebred Holstein in milk production. (03 31 016-2)

2. Management for adaptability. A study comparing systems of feeding and management is in progress at Jeanerette, Louisiana. Preliminary growth rate results indicate very little difference between groups confined to the barn on feed and those allowed to graze with supplemental feeding. When all experimental calves have reached 2 years of age, all data including parasite and feed consumption data will be summarized. (03 31 017-2)

3. Physiological response to environmental stress. At Beltsville, a hygrometric tent system was designed for the separate and simultaneous partitioning of total and respiratory evaporative losses. Sheep were used initially to facilitate handling and minimize maintenance cost. Air flow and dewpoint temperature of intake and exhaust air were continuously monitored and recorded at 40-second intervals, permitting the study of short-term changes in evaporative losses. Percent recovery of moisture averaged 97.1% (C.V. = 1.68).

Surface and respiratory evaporation rates were measured using 9 rams, 3 ewes, and 3 wethers exposed to 24, 35, 38, and 40°C. The rams were divided into 3 wool length groups; closely sheared, medium sheared, and unsheared. All animals exhibited a synchronous type of sweat gland discharge. At 24°C this discharge did not show a distinct pattern. However, at 35, 38, and 40°C, sweating increased and showed a uniform discharge frequency. Closely sheared animals showed a steady decline in volume per reaction for approximately 3 hours, suggesting fatigue of the sweating mechanism. This pattern was not evident in the medium sheared and unsheared groups. These findings indicate that sweating is an effective short-term heat loss mechanism in closely sheared sheep, but that respiratory evaporative heat loss is completely adequate. (03 31 015-1)

At Izatnagar, India, the drugs, adrenaline, pilocarpine, and acetylcholine stimulated sweating in Haryana heifers exposed to cool and hot conditions. The effect of adrenaline was most pronounced at 18.5°C while the animation of acetylcholine and pilocarpine was more pronounced after thermal sweating had been induced. Studies concerning the contribution of sweat glands to the rate of skin evaporation corroborate the assumption that the major portion of the substance available for evaporation from the skin surface of cattle under thermal stress comes from the sweat glands. The skin secretions were found to give high alkaline reactions (ave. pH 7.8). They were hypotonic to blood plasma but contained inorganic phosphorus, nitrogen, and reducing sugars and lactic acid in higher concentration than the blood. The low chloride concentration indicates that cattle under hot conditions do not have a need for large amounts of salt replacement in the diet. (03 31 079)

Publications - USDA and Cooperative Programs

A. Poultry

1. Hormones and stress

Siegel, H. S., J. Latimer and D. Denney. 1967. Steroid production with HADPH by avian adrenals in vitro. Poultry Sci. 46:1319 (Abst.)

2. Temperature and density stress

Deaton, J. W., F. N. Reece and T. H. Vardaman. 1968. Temperature and broiler condemnation. 65th Annual Proceedings - Assn. of Southern Agricultural Workers - p. 214 (Abst.)

Deaton, James W., Floyd N. Reece and Thomas H. Vardaman. 1968. The effect of temperature and density on broiler performance. Poultry Sci. 47:293-300.

Reece, F. N. and J. W. Deaton. 1968. Implications of reduced heat during brooding of broilers. 65th Annual Proceedings - Assn. of Southern Agricultural Workers - pp. 218-219 (Abst.)

3. Physiological response to stress

Bouchillon, C. W., J. W. Deaton and F. N. Reece. 1968. Steady state external thermal energy losses in broilers. 65th Annual Proceedings - Assn. of Southern Agricultural Workers - pp. 213-214 (Abst.)

Deaton, J. W. and F. N. Reece. 1968. Telemetering the body temperature of the broiler chick and effect of induce hypothermia. Poultry Sci. 47:May issue.

Reece, F. N. and J. W. Deaton. 1968. A radio transmitter for telemetering body temperatures of chickens. Poultry Sci. 47:424-428.

B. Beef Cattle

1. Selection for adaptability

DeRouen, T. M., D. C. Meyerhoeffer, W. L. Reynolds, H. C. Gonsoulin and N. T. Poche'. 1968. Response of selection for adaptability of beef cattle to the Gulf Coast Area. Eighth Livestock Producers Day. Dept. of Animal Science, L.S.U.

Jilek, A. F., W. C. Burns, M. Koger and W. T. Butts. 1968. Sire by breed of dam interaction in cattle. J. Animal Sci. 27:1127.

Taylor, R. L. 1967. Genetic and environmental influences upon certain hepatic and blood constituent concentrations in South-western range cattle. Ph.D. Thesis. University of Arizona, Tucson.

C. Dairy Cattle

1. Breeding for adaptability

None

2. Management for adaptability

None

3. Physiological response to environmental stress

None

IMPROVED LIVESTOCK AND POULTRY PRODUCTION MANAGEMENT SYSTEMS
(RPA 313a)--Selection and Breeding Systems

USDA and Cooperative Program

Location of Intramural Work	Commodity	Scientist
		Man-years FY 1968
Georgia	Poultry	0.7
Indiana	Poultry	1.8
Maryland (Beltsville)	Poultry	2.0
Colorado	Beef cattle	2.0
Georgia	Beef cattle	0.1
Montana	Beef cattle	1.2
Nebraska	Beef cattle	1.7
Oklahoma	Beef cattle	0.1
Tennessee	Beef cattle	0.8
Virginia	Beef cattle	0.4
Maryland (Beltsville)	Dairy cattle	4.1
Ohio	Dairy cattle	1.1
Tennessee	Dairy cattle	0.2
Utah	Dairy cattle	1.0
Illinois	Swine	0.2
Indiana	Swine	0.2
Iowa	Swine	0.4
Maryland (Beltsville)	Swine	0.8
Minnesota	Swine	0.2
Montana	Swine	1.0
Nebraska	Swine	0.2
Oklahoma	Swine	0.2
South Dakota	Swine	0.2
Wisconsin	Swine	0.2
Idaho	Sheep	1.3
Maryland (Beltsville)	Sheep	0.9
Indiana	Pioneering labs	1.0
Maryland (Beltsville)	Pioneering labs	2.0
Total		26.0

Intramural program is supplemented by extramural support representing
 (a) 1.7 SMY's at State Agricultural Experiment Stations,
 (b) 0 SMY's at other U.S. institutions, and
 (c) P.L. 480 funds in 6 countries representing \$102.2 thousand equivalent.

IMPROVED LIVESTOCK AND POULTRY PRODUCTION MANAGEMENT SYSTEMS
(RPA 313b)--Systems of Production Management

USDA and Cooperative Program

Location of Intramural Work	Commodity	Scientist
		Man-years FY 1968
Montana	Beef cattle	0.4
Oklahoma	Beef cattle	0.2
Maryland (Beltsville)	Dairy cattle	1.4
Maryland (Beltsville)	Swine	0.6
Idaho	Sheep	1.1
Nebraska	Sheep	0.3
Total		4.0

Intramural program is supplemented by extramural support representing
(a) 0 SMY's at State Agricultural Experiment Stations,
(b) 0 SMY's at other U.S. institutions, and
(c) P.L. 480 funds in 0 countries representing \$0 equivalent.

Problems and Objectives

The annual farm value of livestock and poultry production was \$22.5 billion in 1966. Based on recent trends this value could be from \$30 to \$35 billion in 1980. Production-Management systems embrace the use of labor, feed, equipment, capital, and the animals themselves. It involves coordination among various sectors of the industry; e.g., in the broiler industry the breeder flocks, hatcheries, feed mills, grow-out operations and processing plants. It means developing and using biological and economic data to develop optimum and complete production-management systems. The area is divided into Genetic (RPA 313a) and Management (313b) systems. The potential annual benefit from new technology by 1980 is estimated to be nearly \$3 billion from Genetics and \$1.5 billion from Management.

Major objectives of the research are to:

1. Increase the production efficiency of livestock, poultry and mink by improving selection aids, techniques and breeding systems.
2. Increase the production efficiency of livestock and poultry by improved specific management practices and farm management systems.

RPA 313a - SELECTION AND BREEDING SYSTEMS

Progress - USDA and Cooperative Programs

A. Poultry

1. Genetic-environment interaction. Studies were conducted at Athens, Georgia to determine the importance of genotype-environment interactions in both egg and meat type chickens. Interactions involving stock, growing location, trial, floor space, protein, parent flock, and parent flock location were evaluated in 16 separate trials at nine state experiment stations and the Regional Laboratory. Variance component estimates revealed that although certain genotype-environment interactions were statistically significant, they may account for only a small percentage of the total phenotypic variation in many cases. The poultry breeding industry has changed rapidly from a large number of small local breeders serving small areas to a few very large breeders operating on a national or international basis. The results of these studies indicate that stocks developed under a specific environment apparently perform equally well under diverse environments. (03 29 003)

In another study, preliminary data suggest that while cage density has little effect on egg production, mortality and feed efficiency are influenced by the number of birds per cage unit. (03 29 010)

At Beltsville, egg production in the sixth generation of birds selected under 18- and 24-hour environments showed no improvement over the previous year. The selected lines showed an advantage of 7.1 and 6.5 percentage points over the controls for the 18- and 24-hour populations, respectively. While considerable genetic progress was obtained during early generations of this study, these data suggest that selection progress for egg production after five

generations has become negligible. It appears that the short range effects of selection under these two environments are identical. (03 29 004)

2. Cytogenetics and physiological genetics. Data from two successive generations of progeny from White Leghorn (WL) recipients of blood from gray guinea fowl donors were analyzed at Lafayette, Indiana. Also, data from test matings of the WL on White Rocks were analyzed to determine the genotype of the WL at the dominant white locus. Observation of progeny of treated parents and analysis of test matings indicated that no detectable genetic change had occurred at the loci controlling expression of color. The results raise serious questions regarding reports by other researchers that genetic changes can be induced by transfusion of blood from one species to another. (03 29 009)

Development of parthenogenetic chicken eggs is expressed by either membrane or embryo formation. At Beltsville, double-yolked eggs had a higher frequency of membranes than expected compared with single yolk eggs from the same hens. Injection experiments showed that membranes could be transferred from a non-parthenogenic line into newly laid eggs, but a diffusible substance was not present. Fowl pox did not induce parthenogenesis. Parthenogenetic membranes and membranes from fertile eggs appear similar cytologically.

The chemical triethylene melamine (TEM) was tested to determine effective dosage level, method of treatment and resultant effects on sperm in White Leghorn roosters. The L.D. 50 was 1.00 mg injected into each testis. Sperm concentrations, sperm viability, and optical density readings of the sperm were associated but sperm volumes were not. Fertility, hatchability, and presence of abnormalities of hatching were studied. TEM appears to be a source of genetic diversity in chickens.

Intergeneric hybrids were obtained from pheasant x Japanese quail crosses. Injections of PMS (Pregnant Mare Serum) were continued into chicken x Japanese quail hybrids. Sexual development was enhanced in several of these birds as evidenced by enlarged testes and presence of a foam gland. (03 29 011)

In homograft and immunological studies at Beltsville, one parthenogen has been mated to his dam. Six hens and 4 males are available from this cross. Homografts have been made between individual progeny; all were rejected.

Tests were conducted to determine the feasibility of using the shank of the turkey dam rather than the saddle region as a site for homograft transplants. Wattle skin from each of 14 parthenogens was transplanted to shanks of their respective dams. While this site has been found to be satisfactory for homograft transplants in chickens, it was found to be poorly adapted for similar transplants in turkeys. The main difficulties in turkeys included physical damage during handling, hemorrhage and infection. Of 14 homograft transplants, 8 were successful while 6 were rejected. Four of the 6 listed as rejected had a history of damage. Of 10 autografts made, 1 was listed as being rejected. (03 29 020)

3. Randombred and control populations. It has been found at Lafayette, Indiana, that randombred control populations of chickens can be maintained for at least 10 years without detectable genetic change in economic traits. A comparison of individual, sire family, dam family, individual and dam family and a family index selection system indicates that the rate of progress in improving egg production is greatest from individual selection with sire family, index, individual plus dam and dam family selection being less efficient in the order listed. In a line selected for low body weight and high egg weight, both of these traits have declined suggesting that a physiological ceiling is reached by reducing body size and increasing egg size since a ceiling is not encountered when the reverse selection is practiced. Other studies initiated this year and on which data are being collected include studies designed to quantitate genetic drift effects, to determine effects of social dominance on responses to selection for production, to identify chromosomes or segments which have a differential for metric traits and methods of breaking plateaus in a body weight selected line. The results of this project thus far indicate that control populations presently available are adequate for measuring genetic change and that there are several causes of genetic variation in the chicken which, after evaluation, may permit greater genetic gains in economic traits through selection. (03 29 097)

At Beltsville, sixteen egg production tests in the United States and Canada tested stock at 26 locations. They submitted data covering 16 production traits which were obtained from approximately 48,000 birds. These data were combined with the previous year's data and a statistical treatment applied to reduce the influence of nongenetic variations. Confidence intervals were computed for each trait of each stock to permit reliable predictions to be made as to whether a difference in the reported performance of two stocks was significant. Statistically significant differences in the performance of the 78 stocks tested in 1966-67 were found for all of the 16 traits measured.

Two turkey tests in 1967 provided individual bird data for eight traits. Approximately 2,300 birds representing 20 different stocks were tested. The within-test data were treated with Duncan's Multiple Range Test and were reported with an indication of the statistical significance of the differences in the performance of the stocks in six traits.

Annual reports of the evaluation of performance reflect the results of the continuous efforts of breeders to improve their stock. Approximately 25,000 egg production test reports and 5,000 turkey test reports were published and distributed to poultrymen in the U.S. and 47 foreign countries in 1967-68. (03 29 060)

4. Selection studies. At Beltsville, 600 broiler-type chickens were individually fed from 5 to 10 weeks of age in each of two generations to determine gain, feed consumption and feed efficiency. Metabolic efficiency was measured as the variation in gain independent of feed consumption and 5-week body weight. The heritability estimate of metabolic efficiency was approximately 0.40. The results of correlation analysis suggest that while short-term selection for gain alone would increase feed efficiency most effectively over

a short period, it may be important to emphasize selection for metabolic efficiency if long-term gains in feed efficiency are to be made. (03 29 012)

5. Genetic plateaus in Japanese quail. Individual phenotypic selection for four-week body weight of quail reared under two different nutritional environments has resulted in considerable genetic improvement under both environments in a study at Beltsville. Quail of the P population (selected on a 28% protein diet) were 41 grams heavier than nonselected controls, while the T population birds (selected on a 20% protein diet + 0.2% thiouracil) were 36 grams heavier than their controls after 10 generations of selection. A 52% increase in four-week body weight has been realized under both environments. (03 29 013)

6. Breeds and breeding systems. In India, evaluation of the White Leghorn, Rhode Island Red and Desi strains indicates a tremendous advantage of the White Leghorn and Rhode Island Red over the Desi. Hen-day egg production was 192, 191 and 37.5 for the three breeds, respectively. Rearing mortality was about five times as great in the Desi and total mortality about twice as large. Feed efficiency was also poorer in the Desi. Crosses between these breeds have been made and progeny are being evaluated. (03 29 052)

Comparisons of the White Leghorn (WL) and Desi breeds and their reciprocal crosses also were made in India. The Desi breed had higher fertility and hatchability than the White Leghorn, but the mortality was higher in progeny of the Desi. The WL male x Desi female had higher fertility and hatchability than the reciprocal cross, but the reciprocal had a higher survival rate and body weight to four weeks of age. The order of resistance to Spirochaetosis was found to be Desi x WL, WL x Desi, Desi purebreds and WL purebreds. In the case of Newcastle disease the order of resistance was WL x Desi crosses, Desi purebreds and WL. Egg quality data have been collected and are being analyzed. (03 29 054)

Data have been collected on the Fayoumi (F), Dandarawi (D), White Leghorn (WL) and Rhode Island Red (R) and crosses of these breeds in Egypt. Results from purebreds indicate that D has the highest fertility and WL has the highest hatchability, while R is lowest in both of these traits. There is little difference in body weight of F, D or WL up to 24-weeks of age, but R is about 175 grams heavier. There are no marked differences in mortality for the four breeds to 24 weeks. While crosses involving R are heaviest up to 24-weeks of age, there is little difference in body weights of other crosses. The descending order of egg production of purebreds in a 90-day period is F, WL, R and D, but the highest producing crosses are those involving D and the lowest are those involving WL. (03 29 055)

B. Beef Cattle

1. Heterosis. Three years of data are now available through weaning in phase 2 of the crossbreeding study at Miles City, Montana, designed to evaluate maternal qualities of first-cross females. Preliminary evaluations indicate the calving percentage of first-cross females averaged about 2.8

percentage points higher than the overall average for Hereford, Angus, and Charolais cows. Average weaning weights of steer and heifer calves from first-cross dams exceeded the overall average for steers and heifer calves from cows of the three beef breeds by 13.7 lbs. and 1.3 lbs., respectively. Weaning data are available on two crops of calves in phase 3, to compare merits of within-breed crossing with two-breed and three-breed rotational crossing. The crossing systems thus far appear superior to within-breed mating for weaning weight, but the limited data are otherwise inconclusive. (03 30 025)

The objective of phase 2 of a study at Blacksburg, Virginia, is to compare the productivity of purebred and crossbred cows when both are producing either three-breed or backcross calves. Tentative conclusions, based on 587 matings representing five calf crops, are: 1) no difference between purebred and crossbred cows in percent calves weaned (when calves are crossbred), 2) weaning weights of steer calves were 13 lbs. and those of heifer calves were 23 lbs. in favor of crossbred dams, 3) steer calves from crossbred dams weighed 25 lbs. more at time of slaughter and had heavier carcasses by 16 lbs., compared to steers from purebred dams, and 4) heifer calves from crossbred dams weighed 19 lbs. more at slaughter and had heavier carcasses by 13 lbs., compared to heifer calves from purebred dams. (03 30 003)

2. Heritability values and genetic interrelationships. In a recently completed carcass study at Fort Collins, Colorado, the left sides of both heifer and bull carcasses were used in developing a multiple regression prediction equation for carcass cutability. The prediction in each of the two sexes indicates that fat thickness at the 12th rib, kidney and pelvic fat weight, longissimus dorsi area, and side weight are somewhat more effective in predicting cutability measured as retail values than as retail cut weight. Also using the same data and average daily gain, the within sex heritability estimates and genetic correlations were obtained. The magnitude of the heritability estimates indicates that progress could be achieved through selection for both gain and carcass merit in beef cattle. Preliminary analyses of the effect of the date of the dam's first calving on lifetime production was measured as number of calves and total pounds of weaning weight. The data indicate that cows calving early the first time tend to calve earlier thereafter and those calving early appear to be nearer the optimum for maximum daily gain of calves. (03 30 005)

The results in New Mexico showed that carcass weight, loin-eye area, and fat thickness are useful indicators of pounds of retail trimmed high priced cuts but not for percent of retail trimmed high priced cuts. Results in Hawaii have shown a highly significant correlation between specific gravity and percent trimmed retail cuts (.72), weight of kidney fat (-.59) and percentage of trimmed round (.71).

All stations that reported on crossbreeding or linecrossing (Arizona, California, U.S. Range Livestock Station, and Oregon) showed that the crosses outdid the straightbred in all cases. In the linecrossing experiment, Arizona reported that the difference was due to maternal effect rather than to genetic potential. (03 30 047-1)

A preliminary analysis to evaluate selection response in three selection lines of Hereford cattle at Crawford, Nebraska, indicated that selection for one generation has been effective in improving weaning weight, yearling weight and an index combining yearling weight and muscling score. Estimates of realized heritability for weaning weight were $0.37 \pm .11$ for bulls and $0.43 \pm .10$ for heifers; yearling, $0.37 \pm .14$ and $0.87 \pm .21$; index $0.69 \pm .21$ and $0.28 \pm .10$. Genetic correlations estimated from direct and indirect response of traits were 0.63 and 0.93 between weaning weight and yearling weight, 0.92 and 1.40 between weaning weight and index, and 0.10 and 1.07 between yearling weight and index in bulls and heifers, respectively. Heterosis of milk production was evaluated in the experiment involving Hereford, Angus, and Shorthorn cattle. Results indicate heterosis effects of 1.6%, 8.5%, 6.8%, and 38.0% at 2 weeks, 6 weeks, June (avg. age 3-1/2 months) and weaning observations, respectively. Data from steers produced in the heterosis experiment were analyzed to evaluate genetic variation in growth and yield of closely trimmed boneless retail products from the carcass and various wholesale cuts of beef cattle. Results indicated that growth of retail products from the carcass is highly heritable (67%) while variation in yield of retail products is moderately heritable (41%). Variation in yield of retail products is due to differential growth rate of muscle vs. fat trim and bone. Phenotypic variance in growth of retail product is 5.5 times greater than that in yield of retail product. (03 30 022)

In cooperative work in the south, it is reported from Texas that correlations (genetic, environmental and phenotypic) exceed 0.93 for initial proliferation rate of body mass and rate at which asymptotic weight is approached and that a wide range in cow size seems equally suitable when each is evaluated at its point of maximum efficiency. Selection for and against fat at the Iberia station gives early evidence of being successful. Arkansas data indicate an antagonism between the genetic effects for growth and maternal ability on birth weight. A report from South Carolina failed to detect a negative relationship between preweaning growth rate of heifers and the maternal environment subsequently provided as dams. Tennessee workers observed change in cow fat during the nursing period to be associated with weaning condition of calves. It was reported at North Carolina that postweaning gain of bulls was unaffected by age of dam. Alabama and Louisiana reported heavier weaning weights for three-breed than for two-breed crosses. Texas reported 39 reagents and 55 anti-sera presently available. Texas and Florida were unsuccessful in attempts to differentiate between cattle exhibiting several anomalies and normal cattle on the basis of biochemical and cytological properties. Front Royal reported inbreds calving 4.5 days later than non-inbreds. (03 30 047-3)

Most beef cows reached maximum fall weights between 6 and 8 years of age, after adjustment for nursing and pregnancy status, year and inbreeding. In work at Front Royal, Virginia, it was found that a cow's fall weight can be estimated from age alone, using this prediction equation: $Y = 600 + 150X - 10X^2$, where Y is weight in pounds and X is age in years. Intense inbreeding in the inbred lines and mild inbreeding in the type selection lines of both the Angus and Shorthorn breeds decreased the cows' mature weights by one to eight lbs. for each additional one percent inbreeding. In contrast, it had

a low positive and non-significant effect in growth selection lines of the two breeds. Bulls' conception rates were 3.2% higher their second year of service than when used as yearlings for pasture breeding in a 75-day season. Non-inbred bulls' conception rates were 7.2% above those of inbreds in the study of 51 sires and 1,865 matings over a 7-year period. (03 30 019)

Work to develop effective measurement procedures for traits of economic value and to estimate related genetic and phenotypic parameters has continued at Lincoln, Nebraska. Analyses conducted at 3 locations during the year indicate that selection for yield and particularly growth of retail product should be effective. Selection experiments involving closed lines being selected for various single traits or indexes involving pre- and post-weaning growth, conformation, carcass quality and composition are in progress at five locations. Experiments to characterize breeds and to determine the degree of heterosis among their crosses are underway at 5 locations. The breeds involved in these experiments include Angus, Hereford, Shorthorn, Charolais, Holstein, Brown Swiss, Milking Shorthorn, and Red Poll. Results continue to reveal an appreciable level of heterosis for growth rate, fertility, and mothering ability. Experiments are in progress at 2 locations to evaluate effects of inbreeding and line crossing. Results of an analysis published during the year indicate that breeders could close their herd and use as few as 4 unrelated bulls without suffering severe inbreeding effects. Preliminary results from crossing inbred lines of the Hereford breed indicate an appreciable amount of heterosis may be obtained. (03 30 047-2)

3. Scores by breed classifiers. At El Reno, Oklahoma, official breed classifiers scored the same cows during the spring and fall for two years. There was a general trend for increased agreement between different classifiers from the first to fourth classification. Classifiers agreed more closely with each other on scores for older cows than for scores on cows which were 2 years old when first classified. Individual classifiers were able to repeat scores at different times on older cows with more accuracy than on younger cows. Correlations between scores at different times on younger cows were generally low. Interactions between cows, seasons, and classifiers were more important in younger cows. Correlations of spring scores near the time the cows were calving with calf weaning weights and grades were near zero for 2- and 3-year old cows but were positive for older cows. Correlations of fall scores after weaning with calf weaning weights and grades were essentially zero for 3- and 4-year old cows but were negative for 2-year old cows. Correlations between scores of slaughter cattle and hot carcass weight, fat thickness per cwt., percent retail cuts and percent trimmed round indicated classifiers scored heavier, fatter slaughter animals higher. (03 30 006)

4. Cyto- and physiological genetics. At College Station, Texas, metaphase chromosomes from peripheral blood cultures were examined from calves exhibiting the following anomalies: 1) stifle joints solidly flexed, 2) spastic paresis, 3) muscle hypertrophy, 4) two-headed, 5) snorter dwarf. In all cases, the chromosomes were morphologically similar to those of normal cattle. Testicular tissue from 25 bulls of various breeds was examined for prophase I meiotic configurations. Diplonema and diakinesis cells were only rarely

seen, whereas pachytene nuclei were always present in large numbers. During diplonema, end-to-end pairing of the X and the Y chromosomes could be discerned. At diakinesis, the centromeral ends of the chromosomes appeared to orient themselves with the centromeres even before the centromere reached the cell poles. No pairing irregularities indicative of translocations, inversions, deletions or duplications were evident in any of the animals used in this study. In an immunogenetics study, a total of 39 reagents and 55 antisera have been produced since initiation of the program. A program to determine milk protein polymorphism involving α casein, β casein, α lactoglobulin, κ casein has been initiated. Indications are that variations are detectable in beef cattle breeds and that a simplified test can be developed for their detection. (03 30 015)

At Gainesville, Florida, dwarf carrier cattle have not been found to differ from non-carriers to a degree sufficient for diagnostic purposes in the factors studied to date. (03 30 009)

5. Inbreeding and linebreeding. The study of the effects of inbreeding on reproduction at Brookings, South Dakota, are only in the preliminary summary stage. Indications are that percent calf crop born has been depressed by inbreeding practiced over the past 12 years. Percent weaned is also depressed but less than calf crop. There appears to be line differences in livability from birth to weaning as well as percent calf crop. A study to estimate heritability and genetic correlations for weaning, feedlot, and carcass composition and quality traits was conducted. Some of the heritability estimates obtained were weaning weight, .40; daily gain, .55; final weight, .85; final conformation, .45; rib eye area, .25; fat thickness, .57; edible portion, .38; marbling, .31; and Warner Bratzler shear (tenderness) 0. (03 30 020)

At Miles City, Montana, phase 2 linecrossing to compare maternal qualities of linecross and straightline heifers has been completed with the final yearling weights of bulls and heifers being taken at the end of the past winter feeding period. A four-year summary of weaning weights of calves from the two groups of heifers showed a 9.5 lb. (2.8%) and 13.5 lb. (3.8%) advantage, respectively, for the heifers and bulls from the linecross heifers. A small advantage (1.9%) for weaning score was observed in the bull calves from the linecross heifers. No appreciable difference was observed in yearling weights as observed in the bulls on full feed from the two heifer groups. An evaluation of fertility showed a 14.6% advantage for the linecross heifers in number of calves weaned.

Phase 3 linecrossing, comparing calves from straightbred matings with two-way and three-way rotations among four inbred lines, has produced two calf crops. Weaning weights for the first group of calves born in 1967 have been summarized. For that year, heifer and bull data were averaged together because of limited numbers. Adjusted weaning weights for straightbred, two-way and three-way calves were 394.5, 413.5, and 435.0 lb., respectively. The three-way calves showed a 3.6 and 5.4% advantage in wean score, respectively, over two-way and straightbred calves.

Three inbred lines are being continued with emphasis on selection procedures to determine the amount of progress being made for some of the important traits such as weaning weight and score, feedlot gain, yearling weight and score. One line of cattle is being continued with emphasis on low external fat cover and high yearling weight/day of age. (03 30 048)

6. Genetic-environment interaction. At Miles City, Montana, calves from a herd of Montana origin have been quite consistently growthier than calves from a genetically different herd of Florida origin. As yet, there is no positive evidence of a time trend in the magnitude of differences between these two herds in Montana. Progeny of sires produced in herds of genetically similar foundation in Montana and Florida and selected for performance at the location in which raised are compared in Montana. Weaning data on the first crop of calves failed to show clear differences attributable to selection of sires on performance under the two different environments. (03 30 012-1)

At Reno, Nevada, a completed 3-year study of the feed efficiency of young bulls during a post-test fattening period, showed that there were significant differences among the Reno lines in the percent of carcass fat initially and at the end of the fattening period. The line-4 bulls consumed more feed per day, gained more weight per day, and were heavier at the time of slaughter than contemporaries in line 5. Although the within-location differences between lines of cattle for other characteristics were non-significant, a large difference has been observed in growth characteristics of calves under the different environments. Also there is some indication from the post-fattening trends that selection for conformation has resulted in an increase in the amount of fat in the carcass. (03 30 010)

Terminal groups of steers at the three locations involved in the genotype-environment study at Raleigh, North Carolina, completed the postweaning gain test and were slaughtered. Analyses of data are underway. Data from 189 bulls, performance tested during an 8-year period, were studied to determine the appropriateness of correcting postweaning bull performance for age of dam. There was no indication of significant age of dam effects for daily gain from 205 to 365 days. Age of dam effects were larger, but not significant, for 205-day weight and 365-day weight for these bulls. (03 30 007)

At Madison, Wisconsin, the twins are calving for the third time and the data are being collected on the third post partum intervals. Data from a previous phase of this experiment have been analyzed to evaluate efficiency of production and cow size in beef cattle. The estimates of efficiency were negatively related to cow weight at calving, positively, but seldom significantly, associated with cow height at withers and negatively related to the ratio of weight to height at withers, an indicator of degree of fatness. These relationships led to the hypothesis that fatter cows are less efficient producers of calves and that skeletally large and small cows are approximately equal in efficiency. Age at calving or reproductive performance appeared to be the most important single variable for predicting differences in estimates of efficiency of production. (03 30 014)

C. Dairy Cattle

1. Dairy Herd Improvement (DHIA)

(a) Performance testing. More than 1,850,000 new lactation records were received at Beltsville, increasing the total available for genetic appraisals of bulls and cows to about 8.5 million. Sire summaries were calculated on 4,800 bulls available through Artificial Insemination and 19,200 farmer-owned bulls. Resummarization was completed on 31,670 older bulls using the latest genetic and statistical techniques, and the results published. Evaluation of pedigrees of present bulls and cows that include these bulls will be more accurate using the updated summaries.

The first cooperative USDA-breed association sire summaries were published. The USDA furnished genetic information on yield traits and breed associations added progeny physical characteristics. This resulted in the most complete and accurate appraisals of the transmitting ability of dairy bulls that have ever been available.

Computer-produced listings of sire summaries on bulls readily available through Artificial Insemination were mailed to extension dairymen, bull studs, and breed associations within 24 hours of the completion of each sire summary run. This new method makes the most up-to-date genetic information on AI bulls available to the dairy industry within 3 days of the conclusion of each sire summary run, as opposed to the 3 months that it took previously. Major revisions were made to the cow evaluation system to improve its reliability. Approximately 700,000 cows were indexed and the top 2% in genetic transmitting ability were published for the industry's use in identifying genetically superior cows. The more effective use of this genetic information on bulls and cows would result in a cost saving of \$140 million per year to the dairy industry. (03 31 039)

(b) Sire evaluation methods and population genetics. Research results at Beltsville indicate that the profitability of the dairy cow population could be increased considerably by greater use of the genetically superior bulls that are presently available through Artificial Insemination organizations. The profit obtained from a 50-cow milking herd would increase by over \$1,000 per year. The daughters of bulls that are genetically superior in transmitting high milk production tend to consume more forage voluntarily and to be more efficient converting feed to milk. These characteristics will become more important in the future when there will be more competition from humans for the world's grain supplies.

The average milk production of U.S. dairy cattle could be increased at a much more rapid rate if information in the USDA-DHIA Sire Summaries was more widely used to spread superior germ plasm for milk production throughout the population. This would mean that the milk necessary for the human population could be produced with fewer cows and less use of natural resources. Methods for estimating breeding values of cows for yield traits more accurately were developed and published to help dairymen and dairy scientists identify genetically superior cows. Results of crossbreeding three breeds of dairy cows

indicated that some crossbreds may have an economic superiority over the pure breeds that were crossed. This could have an important application in upgrading the economic value of cattle in certain areas. (03 31 041)

2. Crossbreeding. Two- and three-breed crosses among Ayrshire, Brown Swiss, and Holsteins were compared to contemporary purebreds at Beltsville to determine the effect of crossbreeding on the incidence of diseases. Using 22 measures of health from birth to calving, the rate of illnesses per 100 calves were 64, 78, and 140 for Ayrshire, Holsteins and Brown Swiss, respectively. The cross combination averaged fewer illnesses than the parental mean indicating some heterosis for calfhood health. During the first lactation, however, the crosses had more health problems than the parental mean. Losses of female calves born alive were 3% less in the crosses than in the purebreds. (03 31 008-1)

The milking characteristics of the three breeding groups were evaluated at Beltsville; outcross and linebred Holsteins and crosses involving Holstein, Ayrshire, and Brown Swiss. In general, the maximum rate of flow increased with lactation number and tends to decrease within lactation from 30 ± 15 days until the end of lactation. There was a significant positive correlation between maximum milking rate and yield of 0.50. Within cow within lactation measure of maximum rate was quite repeatable. The outcrosses had the highest maximum rate of any yield in maximum rate followed by the linebred and crossbred groups. There were no differences among mating system groups for the duration of maximum rate of flow or the total milking time. These studies indicated that maximum rate of flow is associated with total yield. The groups with the total yield milked enough faster to maintain the same milking time. The average milk production of 18,530, 17,007, and 16,149 lb. for the outcrosses, linebred and crossbreds indicates the merit of using sires with superior AI proofs. (03 31 009)

At Lafayette, Indiana, growth data on the second crop of calves (Red Dane, Holstein and Friesian crosses) indicate varying degrees of heterosis. Male calves exhibited more heterosis than females. For example, at 3 months of age the percent heterosis for weight was 12.0 and 1.9% for males and females, respectively. At 6 months the values were 11.1 and 4.1% for the two sexes. Carcass and feed efficiency data collected on male calves are being summarized. (03 31 008-2)

3. Genetics of feed utilization among sires and environments. Data on milk production, feed consumption and body weight were collected on 661 lactations of 318 Holstein cows by 17 sires at Beltsville. Least squares analysis of variance indicated that weight change from calving to the end of lactation had the greatest effect on feed efficiency among the factors studied. Year effects on efficiency were not significant in the first parity, but were on an overall lactation basis. The genetic correlation based on the intra sire daughter-dam regressions (using only first parity dams) between efficiency and production, efficiency and body weight, and body weight and production were 0.92, -0.17, and 0.28, respectively. The heritability of efficiency

was 0.46 as opposed to 0.62 for production. It was concluded that selection on the basis of yield alone would increase the genetic potential for feed efficiency. However, a more effective selection procedure may result if some attention were given to body weight in addition to production. (03 31 001-1)

4. Genetic-environment interaction. Matings to project sires were completed at Logan, Utah. Feeding trials for Phase I were completed with information on 211 daughters of 14 sires. Final summarization of consumption, production and efficiency data by biweekly and lactational periods was begun. Initial analysis showed highly significant differences between sires and between rations in consumption, production and gross feed efficiency. Sire X Ration interactions were not significant for any of the three measures. The correlation between consumption and gross efficiency was not significantly different from zero while the correlation between production and gross efficiency was .77, indicating that, under present conditions, selection on the basis of production is the most practical approach for increasing both production and gross feed efficiency in dairy cattle.

Phase II of the project continued as outlined with 68 daughters of 6 sires having completed the milking phase. The collection and periodic summarization of data for milk, butterfat, solids-not-fat, and protein production, feed consumption, feed analysis, body weight and body measurements were continued. (03 31 001-2)

The data-collection phase of the genetic-environmental interaction study was completed at Lewisburg, Tennessee. A preliminary analysis assuming a mixed model with sires as a random variable, indicated that 2-4% of the variation in production variables was due to the sire by ration interaction component. Forage intake increased in early lactation reaching a plateau by the 12th week for the grain fed group and by the 14-16th week in the all forage group. Heritability estimates for roughage dry matter intake derived from the sire components were .61 and .0 for the grain ration and all forage group, respectively. (03 31 001-3)

5. Dairy-beef characteristics. Records of progeny from 5 Milking Shorthorn sires, 57 males and 62 females born from 1959 through 1966 were analyzed at St. Paul, Minnesota. Heritability estimates indicate that selection would be effective for the following traits: milk yield and milk fat in daughters; average daily gain, average daily gain from birth, fat cover over 12th rib, dressing percent, carcass grade, percent kidney fat, marbling score in sons. There were positive moment correlations between daily gain and milk fat yield, dressing percent, average daily gain from birth; between dressing percent and weight of fat on carcass, weight of bone in carcass, percent kidney fat, marbling score. From the limited data available if selection were for increased milk, there would be a beneficial effect on average daily gain of steers and increased dressing percent. There would be a detrimental effect on carcass grade and marbling score.

Selection for high average milk production continues to show results. The herd averages 12,876 lb. milk, 512 lb. fat M.E., an increase of 992 lb. of milk and 44 lb. of fat over last year. (03 31 057)

6. Progeny testing. Young bulls produced in the Beltsville herd have been loaned to cooperating dairymen, public institutions, and AI studs for proving. The 8 bulls in service at the close of this year had proofs ranging from -1,468 to +1,412. This difference in the performance of bulls from one herd selected on available pedigree information emphasizes the need for proving bulls prior to their extensive use in AI. (03 31 010)

The comparison of daughters of highly proven AI bulls and selected linebred bulls has continued at St. Paul, Minnesota. To date, 48 daughters of 4 highly proven AI sires have averaged 12,754 lb. of milk. Thirty-seven contemporary daughters of 9 linebred sires averaged 10,892 lb. of milk. The average difference of 1,862 lb. in favor of the AI sires illustrates the potential increase in milk production possible when sires are selected because of their proven superiority. (03 31 011)

7. General and specific combining ability. For the past 2-1/2 generations at Columbus, Ohio, 6 lines of cattle have been developed which now have a relationship of approximately 25%. Within the past 3 years, these lines have been crossed simultaneously to develop line cross progeny for estimation of combining abilities. The line crosses will continue until various cells in the design are filled. Sufficient numbers of females should be insured if crosses continue through 1968. (03 31 007)

8. Physiological genetics. At Columbus, Ohio, variation in serum transferrin, seven blood groups, and three milk protein systems was studied in relation to four body measurements taken at various ages on about 2,000 Holstein cattle. No clear-cut evidences of association between polymorphisms and variations in body measurements were detected. It appears that the genetic polymorphisms studied are of no use in predicting growth in Holstein cattle. A technique for freezing cattle erythrocytes in liquid nitrogen was developed. The technique yields 60.4% of the cells originally frozen. They appear to be comparable to fresh cells in serological reactions. This development gives more versatility to blood typing and makes the process more efficient. Blood types and estimates of transmitting ability for production were compared for 1,582 Holstein bulls (USDA Predicted Difference or PD). Analyses completed within paternal half-sib families indicate that both B and L systems are related ($P < .01$) to the PD values for milk. These relationships were significant ($P < .05$) when adjustments were made for effects associated with half-sib families and some other blood systems. Although some significant relationships were found, it will not be feasible to use blood type information in selecting young bulls for service until a much greater amount of the variation in PD can be explained by genetic markers. Serum transaminase levels in 400 blood samples from 142 cows were related to season and seemed also to be related to stage of gestation. A direct relationship to production was not found. The data suggest that several different mechanisms may be involved in control of the transaminase enzymes in blood. (03 31 056)

D. Swine

1. Inbreeding. Data on 7,075 litters from eight cooperating agricultural experiment stations were analyzed at Ames, Iowa, to determine the effect of inbreeding and of age of dam on litter size, litter weight and pig weight from birth to 154 days of age. Dam's inbreeding significantly depressed all three traits at birth, but had practically no direct effect on number weaned or on litter size or pig weight at 154 days. It did, however, retain a significant direct effect on both pig weight and litter weight at weaning as well as on litter weight at 154 days. The inbreeding of the litter had practically no influence on litter size at birth, but showed a significant influence on pig's birth weight as well as on weaning and on 154-day litter traits, with the regression on pig's inbreeding showing a significant departure from linearity for all weaning traits. Age of dam had a significant curvilinear effect on all traits at birth with peak performance shown by gilts between 15 to 17 months at farrowing. Age of dam retained a significant effect on pig weight at weaning but had no effect on number of pigs weaned.

Effects of inbreeding were simulated with Monte Carlo studies in a 3 generation selection experiment using 3 different-sized breeding groups. There were 16 lines each with 1 sire and 10 dams, 8 lines each with 2 sires and 20 dams, and 4 lines each with 4 sires and 40 dams per generation. Selection was entirely within lines, with the same number of parents maintained each generation. The results show that inbreeding as practiced in the 1-sire lines may act as a severe deterrent to genetic advance. At moderate to low rates of inbreeding as in the 2- and 4-sire lines, selection can be effective in maintaining or improving genetic merit, with the rate of improvement depending on the heritability of the traits selected for, the selection pressure applied, and the magnitude and the sign of the genetic correlations between traits. (03 32 012)

2. Combining ability. Selection for specific combining ability at Beltsville has resulted in two selected lines (7-1, 8-1) along with two relatively unselected control lines (7-2, 8-2). Reciprocal crosses made between the two lines within each set show that heterosis effects in the 7-1 x 8-1 crosses substantially exceeded those in the 7-2 x 8-2 crosses for most of the traits studied. Litter size at weaning in the 7-1 x 8-1 crosses exceeded that of their parental lines by 1.05 pig or by 17.2%, whereas in the 7-2 x 8-2 crosses litter size for crosses was actually slightly inferior to the average of their respective parental lines. In litter weight at weaning the advantage for 7-1 x 8-1 crosses was 74.4 lbs. or 30.2% relative to their parental lines, whereas in 7-2 x 8-2 crosses the respective advantage for crosses was only 37.5 lbs. or 13.9%. These results suggest rather strongly that reciprocal recurrent selection as practiced in this project has been effective in improving the performance of crosses. (03 32 003)

Data on 376 BB and 301 LL strain litters born from 1957 through 1966 at Beltsville, Maryland, and on 251 Montana No. 1 litters born from 1957 through 1963 at Miles City, Montana, were used to reestimate genetic and environmental changes in litter size and litter weight at birth and at 21 and 56 days of age.

Least squares constants for year effects generally showed an upward trend in the Beltsville strains and a downward trend in the Miles City strain, but none of the linear regressions on years were significant. In contrast, constants for generation effects generally showed a downward trend in the Beltsville strains and an upward trend in the Miles City strain, but regressions on generation number also were not significant for any of the traits. Maternal effects associated with differences in age between 2-year old sows and gilts were significant only for litter weight at birth in the Miles City strain, whereas in the Beltsville strains they were significant for all traits. (03 32 001)

The influence of genetic factors on pork quality was studied in 650 pigs from 280 dams, 89 sires and seven lines of breeding during 5 seasons at the Stillwater and Fort Reno Stations. In the overall analysis including both sexes, backfat thickness, carcass length, loin-eye area, yield of lean cuts, ether extract and total moisture were highly heritable ($h^2 \geq 0.40$). Marbling and firmness scores, average penetrometer and shear value were moderately heritable ($0.20 \leq h^2 \leq 0.40$). Age at slaughter and color score were lowly heritable ($h^2 \leq 0.20$). Phenotypically, probe backfat was more closely correlated with the other traits than was carcass backfat. Backfat thickness was negatively correlated with yield of lean cuts ($P \leq .01$). Most quality traits were significantly correlated with yield of lean cuts but the magnitudes of their relationships were too small to be of practical importance. Most quality traits were favorably correlated among themselves. (03 32 022)

3. Crossbreeding. At St. Paul, Minnesota, comparison of results from a 3-breed rotational cross of Minnesota No. 3, 1 and 2 with those from a 3-breed rotation of Poland, Duroc and Hampshire showed no appreciable difference between the two groups in post-weaning daily gain or efficiency of feed utilization. However, the Minnesota rotation significantly exceeded the standard breed rotation in number of pigs born alive and pigs weaned. The breed rotation in turn showed a significant advantage in carcass value as measured by backfat thickness, loin-eye area and yield of lean cuts. (03 32 005)

4. Physiological genetics. Immunogenetic studies were carried out at Poznan, Poland, on 303 litters (2,439 pigs by 93 boars). There were highly significant differences in frequencies of certain alleles between the White and Spotted strains of Zlotnicka pigs in the E, B, and K blood group systems. The White Zlotnicka is a bacon strain while the Spotted is fatter or lard-type strain. There were also significant differences between the White Zlotnicka and the primitive Nadbuzanska breed in the A, B, E, F, K, and L systems. The data on gene frequencies in these breeds provide pertinent information for comparison with similar data on other breeds throughout the world. Such information will be useful in tracing the development of the various breeds of swine. Four production traits were studied: slaughter age, carcass length, lean percentage of ham, fat/lean ratio. Heritability estimates for these four traits were 0.45, 0.41, 0.71, and 0.69, respectively. The average values for animals having a given blood factor were compared with the averages for the animals not having the blood factor. (03 32 027)

In another study at Poznan, Poland, sixteen isoimmunizations were made and 10 immune sera obtained. Four hundred pigs were blood typed using 36 test sera representing 14 blood group systems. This project was activated March 15, 1968; therefore, this report represents three and one-half months work. Data on 2,325 pigs from previous studies are being analyzed for relationships between blood groups and seven different growth and carcass traits. (03 32 031)

5. Heritability of semen constituents. Data collected on semen samples of 112 Yorkshire boars were used at Lafayette, Indiana, to evaluate the effects of heredity on sperm number, lactic acid and fructose concentrations, pH and sperm motility. Estimates of heritability derived from paternal half sib correlations were $0.64 \pm .45$, $1.00 \pm .42$, $0.03 \pm .40$, $0.00 \pm .33$ and $0.18 \pm .24$, respectively, for the five traits. These results suggest that sperm number and lactic acid concentration are rather highly heritable characteristics, while the other three semen traits are lowly heritable. (03 32 006)

6. Conversion technique for ultrasonic readings. A plotting routine was developed in Fortran IV language, version 13, to facilitate rapid conversion of ultrasonic loin-eye area readings to graphic form. (03 32 006)

E. Sheep

1. Inbreeding. Fifteen years of mass selection, primarily for an index of overall merit plus polledness, in a closed but lowly inbred group of Rambouillet sheep at Dubois, Idaho, resulted in average annual genetic gains of 1.3% of the range for index and 2.0% for horn score (in males only). Face covering, which received most emphasis in the index, improved 1.4% annually. Genetic changes in eighteen other weanling and yearling traits studied ranged from 0.0 to 0.9% annually. Changes in four of six reproductive traits, not included in the index, showed progress although none was significant. These results show that highly worthwhile permanent improvement in the overall merit of a breeding flock of sheep can be achieved well within a man's productive lifetime by sustained mass selection within a closed flock if inbreeding is held low. With the exception of polledness, for which independent selection was practiced, clearly the most important changes occurred in traits included in the index, although not all such traits changed. (03 33 004)

Among 36 classes of birth defects in 52,422 births of Rambouillet, Targhee and Columbia sheep the frequencies (per thousand births) of stillbirths (44.2) and abortions (29.8) were the highest. The next most frequent defects were those related to the fleece, i.e., black or brown spots on legs or face (19.4), black spots in the fleece (18.8), hairy birth coat (13.9). Certain anatomical defects were next, namely, short lower jaw (3.8), crooked legs, feet and ankles (2.4), and long lower jaw (2.1). With the exception of black legs (1.9) and notched or large scrotum (1.2), all other defects, mostly anatomical, occurred less than 1.0 per thousand births. Comparing the incidence in inbred groups with that in noninbred selected groups and noninbred unselected groups revealed that the incidence was highest in the inbred groups for 28 of the 36 classes of defects. In eight out of nine cases where differences between the groups were statistically significant, the highest frequencies occurred in the inbred groups, thus corroborating genetic theory that inbreeding tends to uncover genetic defects. It appears that the frequencies of about 75% of the defects noted were low enough to be unimportant in the groups as a whole, but

several defects were extremely important in specific inbred lines. It is significant that although the frequencies of many defects are higher in the inbred lines, in general, the incidence is still low enough to be a negligible deterrent to inbreeding in sheep. (03 33 003)

A comparison of the incidence of birth defects in topcross offspring from different inbred lines revealed that the incidence among topcross offspring had almost no correlation with the incidence among inbred offspring from the same lines. The average incidence of most defects in the topcross offspring is typically from 50 to 100% less than in the inbred offspring. For about 7% of the defects, particularly for black or brown spots in the fleece and on the face and legs, the incidence was actually higher in the topcross than in the inbred progeny, suggesting that the defects in these few cases possibly were more prevalent in the noninbred parents. It is significant that differences in merit (as measured by the presence of birth defects) which are clearly evident among inbred offspring from different lines generally almost completely disappear when measured on topcross offspring from those same lines. (03 33 007)

2. Crossbreeding. Hampshire, Columbia-Southdale, Targhee, Suffolk and Dorset breeds are being compared with respect to their relative merit in a crossbreeding program at Beltsville. All possible crosses and reciprocal crosses were made in the three years 1966, 1967 and 1968. Comparisons were based on an index, considering both pounds of lamb weaned and pounds of wool sheared, adjusted for their relative economic value. Averages for the three years showed that Targhee ewes mated to the other four breeds of rams had the highest average index of 122.3, while purebred matings of Targhee ewes gave an average index of 112.4. Corresponding averages for the other breeds were Hampshire, 95.6 and 66.5; Suffolks, 96.7 and 100.0; Columbia-Southdale, 98.8 and 95.2; and Dorset, 83.8 and 52.9. The low average index for the Dorset was due to low fertility of the Dorset rams apparently resulting from high temperatures before and during breeding. The highest average single crosses resulted from mating Suffolk rams to Targhee ewes (138.5) and from Columbia-Southdale rams to Suffolk ewes (139.5). Indexes from 2-year old two-breed cross ewes mated to rams of a third breed averaged 97.4. (03 33 001)

3. Breed comparisons. Reproductive ability of Targhee sheep was compared at Beltsville, Maryland, and Dubois, Idaho. Three year sample periods were included in the comparison. Viability of ewes from breeding to lambing and viability of lambs at birth were very similar at the two locations. Fertility was higher at Dubois (90.2) than at Beltsville (84.5). Fecundity was higher at Beltsville (174.1) than at Dubois (154.3). Survival of lambs from birth to weaning was higher at Dubois (87.6) than at Beltsville (78.0). Overall reproductive ability based on number of lambs weaned per ewe bred was higher at Dubois (110.9) than at Beltsville (104.6). This might be expected as the Targhee breed has been developed and selected for adaptability for conditions at Dubois. However, climatic conditions are probably more favorable for reproduction at Dubois. Reproductive performance of Targhees at Beltsville compares favorably with other breeds there as well as with average lamb production for the State. (03 33 013)

Hampshire, Columbia-Southdale, Targhee, Suffolk and Dorset breeds are being compared with respect to their production of lamb and wool. This comparison is based on an index that considers both pounds of wool sheared and pounds of lamb weaned adjusted for their relative economic value. Results from three years (1966, 1967, 1968) are available for comparison and show the Targhees to rank first in production with an index of 112.4 followed by the Suffolks with 100.0, Columbia-Southdale with 95.2, Hampshires with 66.5 and Dorset with 52.9. Low indexes in the Hampshires and Dorsets resulted from low fertility apparently due to high temperatures before and during breeding. (03 33 027)

The strain of sheep used in another study at Beltsville had its beginning at Middlebury, Vermont, when in the early 1940's Columbia rams were mated to Corriedale-Southdown cross ewes. In 1951 about 80 of these crossbred ewes were moved to Beltsville where they have been interbred and maintained in a 3 sire line and selected for both lamb and wool production. During 1966, 1967, 1968 a production index (95.2) ranks these sheep above the Hampshire (66.5) and Dorset (52.9) and somewhat below the Suffolk (100.0) and the Targhee (112.4). They compare favorably with the Targhee in wool production and excel over the other breeds in this trait. (03 33 002)

4. Improvement of commercial range sheep. In a selection study involving a large flock of ewes, selection differentials have ranged from 7 to 12 pounds for weaning weight, .03 to .10 centimeters for staple length, a slight advantage for face cover, and horns have practically been eliminated. At yearling age staple length has steadily increased. Any improvement in body weight and fleece weight has been obscured by large yearly sources of variation. (03 33 008)

F. Goats

1. Angora goat performance. Average levels of production in the flock of Angora goats at Ankara, Turkey, were found to be: body weight of does at mating 30.6 kg, body weight at shearing 27.6, grease fleece weight 2.55 kg, percent of does kidding of does bred 88.0%, percent of kids born alive 85.6%, survival of kids to weaning 95%, birth weight of kids 2.4 kg, 45 day weight 8.5 kg, and weaning weight 17.3 kg. Birth weight, 45 day weight, weaning weight, mature body weight, fleece weight and fiber diameter all increased with age of dam up to 6 years of age and then remained fairly constant. Sire progeny groups were averaged for kid weight at several ages, fleece weight and several fleece characteristics. Considerable variation among the sire means were found, indicating that considerable genetic variability may exist in the flock and that the corresponding heritabilities may be quite high. (03 34 012)

G. Mink

1. Genetics of mink. From studies at Madison, Wisconsin, matings on a commercial mink farm showed that three males produced very poorly when mated to a total of 20 females. On checking the blood types these were found to be incompatible matings within the A system. The following spring the same females, when mated to males of compatible blood types, produced normally.

What appears to be a genetic predisposition to fatal anaphylaxis on injection of solutions containing neomycin to mink suitably preconditioned by routine feeding of this substance is under investigation on a large commercial ranch. Only one of four color phases has been so affected during the last three seasons, and only certain families within this color phase.

Blinded mink and ferrets continue to reproduce as well as controls. This indicates that the effects of length of day on reproduction are not transmitted solely through the eyes. (03 34 001)

H. Pioneering Laboratories

1. Basic research on selection. An analysis of experimental data from nine generations of selection for pupa weight in Tribolium, with five different mating systems, has been completed at Lafayette, Indiana. Selection was effective in increasing pupa weight; however, none of the mating systems increased selection response when compared to random mating. These data indicate that with lowly heritable traits there is little reason to deviate from random mating when individual selection is used to improve livestock.

An experiment to determine the type of selection that is most efficient at various levels of heritability has been initiated with Tribolium castaneum. There will be four selection methods in each of two replications, and in each line 240 offspring will be evaluated from 20 single pair matings. Also, a study was initiated to investigate the possibility of developing mice with rapid early growth without the usual increase in adult body size. There will be a selected line and a control line in each of two replications. In each line, 150 offspring of each sex will be evaluated and 50 of each sex selected. (03 98 010)

2. Basic research on blood antigens and antibodies

(a) Anti-A agglutinins. Two active components have been isolated from new or stored Phaseolus lunatus seed extracts. Ultracentrifugal analysis of these components produced single peaks having sedimentation coefficients of 6.05 S and 9.4 S, respectively. Chromatography of samples on Sephadex G 200 in the presence of 6 M urea-1 M acetic acid reveals partial breakdown to smaller molecular sizes, but the smallest subunit is obtained only after reduction with 0.1 M dithiothreitol or 0.5 M mercaptoethanol in the presence of 6 M urea followed by acidification. The smallest subunit was estimated to have a molecular weight in the region of 45,000 for both components. Both anti-A components have thus been shown to be made up of smaller subunits held together partly by disulfide linkages and possibly also by weak forces such as hydrogen or hydrophobic bonds.

The affect of various concentrations of dithiothreitol and mercaptoethanol on the hemagglutinating activity of these components has also been tested. The higher molecular weight fraction was found to be much more susceptible to reduction, being 80-90% inactivated as compared to the smaller protein which was 15-20% inactivated. Studies have been carried out on the involvement of

free sulfhydryl groups in the activity of the anti-A lectin fractions using 5,5' dithiobis-2-nitrobenzoid acid (Ellman's reagent). A relationship has been established between hemagglutinating activity and the use of Ellman's reagent. (03 98 006)

(b) Somatic cell variation in pigeons. Studies on the inheritance of the A_2^{CL} agglutinin are in progress. Tests of reproducibility of hand titrations were carried out with the blood of a single pigeon over a period of 32 months. Results showed uniformity between values obtained by three different technicians as well as values obtained at a young and at an advanced age of the pigeon.

At high levels of agglutination, the end point titers are highly correlated with the summed score. However, at low levels, only the summed score reflects the magnitude of agglutination at each dilution.

It has been shown that the agglutination of cells is a function of the frequency of A_2^{CL} negative cells and the number of sites on positive cells. The frequency of cells completely without reactivity is very low. A comparison of A_2^{CL} negative red cell frequencies with end point titers indicates a correlation of the two, but also shows that cells without reactivity contribute little to the reduction in titer. A reciprocal titer of 2048 has an associated A_2^{CL} negative cell frequency of less than 5×10^{-5} ; for titers of 512-1024, it is less than 4×10^{-4} , and for a titer of 64, it is less than 2×10^{-2} . Even for titers of 4-8, it is less than 5%. These data suggest that the reduction in agglutination with titer reduction is due to cells with a site number less than maximum rather than A_2^{CL} negative cells. (03 98 008)

(c) Effect of X-Rays on viability of genes. Studies carried out on fitness in Israel show that the mean fitness of heterozygotes for lethals was reduced by about 7.0% per generation. Subvitals were defined so that they overlapped the normal range, yet their fitness in heterozygotes was reduced by about 2% per generation. Normal chromosomes in the irradiated samples did not deviate from unity fitness. The results show that on the average, the fitness of the heterozygotes for a sample of newly induced mutations is correlated with the viability of the homozygotes. These results suggest that the genetic variants found in nature must be very biased samples of those arising by mutations. Therefore, if an important contribution to genetic polymorphism in nature is due to overdominant mutations, it is due to a highly selected sample of mutations. (03 98 009)

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None

B. Beef Cattle

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None

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None

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None

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1. Inbreeding

None

2. Crossbreeding

None

3. Breed comparisons

None

4. Improvement of commercial range sheep

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F. Goats

1. Angora goat performance

None

G. Mink

1. Genetics of mink

None

H. Pioneering Laboratories

1. Basic research on selection

None

2. Basic research on blood antigens and antibodies

(a) Anti-A agglutinins

None

(b) Somatic cell variation in pigeons

None

(c) Effect of X-Rays on viability of genes

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RPA 313b - SYSTEMS OF PRODUCTION MANAGEMENT

Progress - USDA and Cooperative Programs

A. Beef Cattle

1. Spring pasture and range management. The first three year's data of a five-year study at Miles City, Montana, comparing the effects of cool season grasses (Russian Wildrye and Crested Wheat) and the alfalfa grass mixtures on cow-calf production showed an increase in weaning weight and cow fertility. Average weaning weights per cow bred amounted to 394 lbs. for the seeded pastures vs. 337.3 lbs. for native range. This 57 lb. advantage for the seeded pastures was the result of an 18 lb. increase in weaning weight of calf plus a 10% advantage in calves weaned. While the first three years showed a consistent calf weight advantage for the seeded pastures, the fourth year (1967) produced hardly any advantage. This was an excellent moisture year, and native ranges responded favorably and produced calf gains comparable to the seeded pastures. During this past year (1968), a cold dry spring was experienced and the seeded pastures responded much more favorably than the native pastures. Calves during this early season gained almost 0.20 lb. daily more than the ones on native. Cows gained slightly on the seeded pastures while those on native held their own. Fertility data obtained this fall will be evaluated to determine to what extent conception was influenced in cows on the seeded vs. native pastures. (03 30 040)

The seasonal variation in in vitro dry matter digestibility and certain chemical constituents are presented for samples of Midland Bermudagrass taken at the Fort Reno Experiment Station during the years 1966 and 1967. The data indicate a positive relationship between neutral detergent solubles (cell contents), crude protein and in vitro dry matter digestibility. There is a negative relationship between dry matter digestibility and all three fiber fractions. It appears that Midland Bermudagrass is a high-quality forage for only about the first 60 days of the growing season. (03 30 041)

B. Dairy Cattle

1. Dairy herd improvement (DHIA) through recordkeeping. A total of 3,028,267 cows in 62,879 herds were enrolled in four recordkeeping plans. These represent 22.4% of the nation's dairy cows, an increase of 1.3% over the previous year. These cows continue to produce an average of several thousand pounds more milk than cows not enrolled in a recordkeeping program. DHIA newsletters containing detailed data on enrollment, production, feeding, and income characteristics of these herds were published. Approximately 7.5 million

dairy cows were bred by Artificial Insemination (AI) during the year. A DHIA newsletter detailing characteristics of the AI program in this country by breeds, states, and AI organizations was published. A Technical Committee on Testing Methods and Procedures for Computing Lactation Records was formed to provide coordination and leadership for research in these areas. A National Seminar on The Effective Use of Breeding Values of Dairy Cows and Sires for Production Traits was held at Madison, Wisconsin in April 1968. This was attended by representatives of 37 states, Canada, Puerto Rico, and the USDA. Herd summary information detailing a wealth of data on herds enrolled in the recordkeeping program was distributed to all states for use in extension and educational programs. Results of research on an AM-PM alternative sampling program were reported. This program is being investigated as a possible alternative to the present testing programs which may decrease costs to dairymen and increase enrollment in production testing. A DHIA Computing Workshop was held to coordinate dairy record processing throughout the country, especially in relation to those DHIA records reported to USDA for genetic evaluations. (03 31 040)

2. Testing, weighing, measuring and sampling devices. Volumetric calibration test procedures were developed for testing stationary mounted receiver jars. This standard test may be applied by all parties interested in the accuracy of the receiver jar, and is more efficient than using actual milk weights. Two additional calibrated receiver jars, the Surge Weigh Jar 25177 (KIMAX) and Chore-Boy Roll-O-Measure, have been approved for use in DHIA testing. Field tests are in progress on two flow through meters, the Tru-Test and the Waikato. (03 31 061)

3. Testing feed additives. At Beltsville, the efficacy of injecting 50 cc of Impro 5-7 days prior to calving to improve milk production was investigated at Beltsville and eight privately owned herds. An analysis of complete lactation production records and a preliminary summary of breeding and health records indicate no beneficial effect from using Impro.

The efficacy of feeding propylene glycol to reduce the incidence of ketosis was evaluated in a study involving 100 cows. Fifty cows were fed 4 oz twice daily for 8 weeks beginning 2 weeks pre-partum. The results indicate that propylene glycol may be useful in the prevention of ketosis. In addition, it had some usefulness as a treatment when symptoms were detected early. However, in severe cases other methods of treatment were necessary. (03 31 013)

4. Identification methods. Several tests were evaluated for the effectiveness of using a teflon strip 5/8" long x 3/32" in diameter as an implant for internal animal identification. These strips were implanted in the ear and tail of cattle, sheep, and swine. The variables evaluated were migration, tissue damage, ease of recovery and legibility of the implant upon recovery. The results to date indicate that implants can be used satisfactorily when inserted in the ear. The tail implants were difficult to recover, and thus are not satisfactory.

The freeze branding research is still in progress. Preliminary results indicate that a dry ice plus alcohol refrigerant causes less skin and follicular damage at 10, 20, and 30 seconds of exposure and results in more legible brands than liquid nitrogen. On the basis of these results, the following time exposures by ages have given a satisfactory freeze brand; birth through 1 month, 10 seconds; 2-3 months, 15 seconds; 4-8 months, 20 seconds; 9-16 months 25 seconds; and over 16 months of age 30 seconds. (03 31 043)

C. Sheep

1. Grazing and management systems. At Dubois, Idaho, treatment of sheep grazing on mountain range to remove the effect of the senses (taste, smell, sight) in grazing selection showed that different senses predominate in the selection of different classes of forage. Lack of sight seemed to decrease the selection of grasses, while lack of taste or smell decreased selection of certain forbs. Sticky geranium, which provides 40 to 50% of the forage on this range type, is not normally eaten in any quantity by sheep, but was eaten by all of the treated sheep. These results raise the possibility of treating either the sheep or the forage to mask the undesirable features of the forage and increase the available feed on this range. Digestibility and botanical selection of the diet of sheep grazing sagebrush--grass range of good and poor condition was studied between early May and mid June. There were obvious changes in diet selection as the season progressed, and some differences between diets on the good and poor range. This knowledge will aid in determining optimum management of spring ranges in the Intermountain area. (03 33 012)

2. Nutrition and management systems. Through the middle of the breeding season at Dubois, Idaho, variations in feed intake of range ewes from 75 to 150% of NRC recommendations had no effect on ovulation rate or embryo survival. There was a significant negative relationship of body weight gain to numbers of normal embryos. This would indicate that flushing may not be economical during this part of the breeding season.

Early-weaning of lambs (average 85 days of age), self-feeding the lambs a barley-alfalfa pellet on irrigated pasture, and grazing the ewes on dry sagebrush-grass range showed that early-weaned lambs gained as well as those weaned at 130 days of age. Ewes on dry range maintained their body weight through the two-month summer period. Increased demands on mountain range areas are pushing the range sheep off their traditional summer range, and this new system may provide more flexibility or increased capacity to the commercial sheepman.

Artificial weaning of orphan lambs was successful employing automatic feeders and milk replacer (fed warm or cold) and weaning at 25 and 30 pound body weights. This indicates a means of weaning more of lambs born in both once and twice per year lambing and could result in increased income for the sheep producer. (03 33 014)

Preliminary findings from Clay Center, Nebraska indicate that 1) short scrotum lambs gained as fast as rams and faster than wethers, 2) carcass grade and dressing percent of short scrotum lambs were equal to wethers and superior to rams, 3) implanting 3 mg of diethylstilbestrol at birth had no effect on ram growth and carcass traits, 4) creep feeding had no effect on lamb performance and 5) Suffolks were superior in growth and carcass traits and Navajos were consistently inferior among the seven breeding groups. (03 33 032)

Publications--USDA and Cooperative Programs

A. Beef Cattle

1. Spring pasture and range management

Houston, W. R. and J. J. Urick. 1967. Response of range cows and calves to improved spring pastures. Proc. West. Sec. Am. Soc. Ani. Sci. 18:231-236.

McCroskey, J. E., N. E. Brackett and Robert Renbarger. 1968. Seasonal variation in the composition and digestibility of Midland Bermuda-grass. Animal Science Research, A Progress Report 1967-68. Misc. Pub. No. 80, April 1968.

B. Dairy Cattle

1. Dairy herd improvement (DHIA) through recordkeeping

Dairy Herd Improvement Letter. March 1968. DHIA participation report. ARS 44-201.

Dairy Herd Improvement Letter. April 1968. Notes and concepts used in USDA sire summary procedures. ARS 44-202.

Dairy Herd Improvement Letter. May 1968. Artificial insemination (AI) participation report for the United States 1967. ARS 44-204.

Dairy Herd Improvement Letter. August 1968. Production levels of DHIA herds. ARS 44-194.

Dickinson, F. N. and B. T. McDaniel. 1968. Single-milking yield vs. 24-hour yield at three intervals for estimating lactation milk production by the test interval method. J. Dairy Sci. 51:985 (Abst.)

Dickinson, F. N. and M. A. Tomaszewski. 1968. Accuracy of milk check for obtaining milk weights and samples in Dairy Herd Improvement Association testing. J. Dairy Sci. 51:685.

Dickinson, F. N. 1968. The element of surprise in Dairy Herd Improvement Association testing. J. Dairy Sci. 51:90.

McDaniel, B. T., F. N. Dickinson and R. E. McDowell. 1968. Estimating income over feed costs of individual cows. J. Dairy Sci. 51:988 (Abst.)

Miller, R. H. July 1968. The use of artificial insemination for animal improvement in the United States. ARS 44-199.

2. Testing, weighing, measuring and sampling devices

None

3. Testing feed additives

None

4. Identification methods

Hooven, N. W., Jr. 1968. Freeze branding for animal identification.
J. Dairy Sci. 51:146.

C. Sheep

1. Grazing and management systems

Harris, L. E., G. P. Lofgreen, C. J. Kercher, R. J. Raleigh and V. R. Bohman. 1967. Techniques of research in range livestock nutrition. Bulletin 471 (1-86) Utah Agr. Expt. Station. Prepared as a cooperative project of W-94, Western Regional Committee on Range Livestock Nutrition.

Laycock, W. A. 1967. How heavy grazing and protection affect sagebrush-grass ranges. J. Range Mgt. 20:206-213.

2. Nutrition and management systems

Frederiksen, K. R., D. A. Price and R. L. Blackwell. 1967. Environmental factors affecting rate and efficiency of gain and other traits in Rambouillet lambs. J. Animal Sci. 26:667-673.

Hulet, C. V., D. A. Price and W. C. Foote. 1968. Effects of variation in light, month of year, and nutrient intake on reproductive phenomena in ewes during the breeding season. J. Animal Sci. 27:684-690.

Price, D. A. 1967. Performance of early and late weaned range lambs. J. Animal Sci. 26:891-892 (Abst.)

Price, D. A., K. R. Frederiksen and R. D. Humphrey. 1968. Responses of ewe lambs to hay quality and feeding method. Bulletin 495 (15 pgs.) Idaho Agr. Expt. Station.

CONSUMER ACCEPTABILITY OF LIVESTOCK AND POULTRY PRODUCTS
(RPA 409)

USDA and Cooperative Program

Location of Intramural Work	Commodity	Scientist
		Man-years FY 1968
Louisiana	Beef cattle	0.4
Maryland (Beltsville)	Dairy cattle	0.2
Maryland (Beltsville)	Swine	0.7
Missouri	Swine	0.2
Idaho	Sheep	0.2
Maryland (Beltsville)	Sheep	1.0
Maryland (Beltsville)	Other animals	1.0
Maryland (Beltsville)	Pioneering labs	1.0
Total		4.7

Intramural program is supplemented by extramural support representing

(a) 0.2 SMY's at State Agricultural Experiment Stations,

(b) 0 SMY's at other U.S. institutions, and

(c) P.L. 480 funds in 2 countries representing \$57.3 thousand equivalent.

Problems and Objectives

Animal products generally have a high degree of consumer acceptability; however, this varies widely among species and products. We should know why. Concern over the role of fat in the diet has focused attention on the problem of excess fat in beef, pork and lamb. Producing animals without this excess fat could save \$1.5 billion in feed costs which could be passed on to consumers in their meat purchases. Per capita consumption trends for milk and eggs point toward possible acceptance problems for these products. More information is needed concerning what livestock product qualities are desired by consumers, and production should be tailored to their preferences and needs for variety and quality.

Major objectives of the research are to:

1. Improve eggshell and meat quality in poultry.
2. Reduce waste fat and improve tenderness, juiciness and preferred cuts in beef, swine and lamb production.
3. Increase protein content, flavor and odor of milk through production practices.
4. Improve the fineness, length, crimp, strength and color of wool through production practices.
5. Increase pelt quality in mink.

Progress - USDA and Cooperative Programs

A. Poultry

1. Eggshell quality. At Rehovoth, Israel, research continues on factors influencing eggshell quality. The intestinal absorption of calcium was stimulated by the presence of lactose, but the feeding of lactose did not increase egg production or egg weight. Feeding low levels of calcium resulted in lowered production and egg weight, and dietary lactose did not improve this condition. Hens were selected for either heavy- or light-shell secretion to test the effect of calcium mass and turnover in bone on rate of shell secretion. The results indicated that under identical dietary and environmental conditions these factors are not responsible for difference in shell secretion. Either calcium absorption or uterine shell deposition was the limiting factor. In other studies to explain the difference in absorption of calcium in various segments of the intestine, the chemical and electrical gradients between the intestinal lumen and circulation were estimated. The electrochemical potential difference (ECPD) of calcium was calculated from the transmural electrical potential and the activities of blood plasma and intestinal contents. Although there was a relationship, the differences in ECPD could only partially account for the difference in the in vivo calcium absorption from segments of the intestine. (03 29 056)

2. Cottonseed constituents and egg quality. Cottonseed oil containing 0.60% cyclopropenoid fatty acids reduced egg production at levels of 2 and 5% in the laying diet, but not at the 1% level. The oil lowered the quality of fresh eggs and eggs stored for 3 and 6 months. Cottonseed meals containing 2 to 5% total lipids, fed at 10% level, did not affect egg production and did not have an adverse effect on quality of fresh eggs. (03 29 015)

3. Influence of growth hormone on fat metabolism. An attempt was made in Poland to obtain a relatively pure fraction of growth hormone from the crude anterior pituitary preparation used previously. The concentration of STH in the purified fraction could not be determined, presumably because rats prepared for the usual tibia test have not been available. These are now being prepared. The purified fraction acted much like the crude preparation on the lipid content of the blood of hens, but effects were not consistent with either preparation. Some effects of the crude preparation on respiratory metabolism were determined. The results were not decisive, although there was some evidence of increased oxygen consumption following multiple injections. A complicating factor in determination of both blood lipid values and respiratory metabolism is believed to be the laying or nonlaying status of the hen. (03 29 057)

B. Beef Cattle

1. Selection for changes in leanness. At Jeanerette, Louisiana, cattle within breeds are showing trends of separating into their respective lines. Fat thickness between the high and low fat lines was 10.8 mm. and 9.8 mm., respectively, for the Angus. The Brangus high fat and low fat lines were 9.4 mm. and 7.6 mm., respectively. There was no significant difference in weaning weight, growth rate to weaning and conformation score between the two selection lines for the Angus and for the Brangus. Postweaning weight gains showed that bulls from the low fat lines, in the Angus and Brangus, gained at a faster rate than bulls in the high fat lines. The animals slaughtered from the low fat lines in both breeds had slightly more tender lean. (03 30 002-1)

2. Improve palatability. At Knoxville, Tennessee, data on weight, type, and condition of cows and calves were collected at the following approximate ages of the 1967 calves: 135, 190, 235, 295, and 400 days. These data included scores on components of type, viz, length of body, leg, rump and loin, width, muscling and depth. Analyses were completed for a study on beef calf performance during the grazing season as related to changes in dam's weight and fatness as measured ultrasonically and by visual condition score. Correlation between somoscope estimates of fat and subjective condition scores of cows was approximately 0.7. In these data, changes in dam's fat thickness accounted for a significant portion of the variation in calf condition at weaning but did not appear to be related to gain of the calf from birth to weaning. (03 30 004)

C. Dairy Cattle

1. Genetics of milk composition. In cooperation with Ohio and Utah State Universities, the possibility of linkage relationships among blood antigens and other polymorphic traits in milk and blood in cattle was investigated. Genotypes of 6,545 progeny of 259 sires were examined. Significant evidence of linkage was found between the J and γ -lactoglobulin systems (crossover frequency, $\theta = .194 \pm .038$), α_{s1} and k-casein ($\theta = .122 \pm .051$), α_{s1} and β -casein ($\theta = .029 \pm .020$) and the β and k-casein ($\theta = 0$). These results provide some of the first points on the chromosome map for cattle.

The effects of mastitis and artificially produced udder inflammation on proteins in milk were studied by electrophoresis. The studies revealed that the following changes accompanied inflammation: A decrease in the α_{s1} and β -casein, the appearance of new, fast moving zones, an increase in serum albumin, and a decrease in α -lactalbumin.

Data were summarized on over 3,600 cows of five dairy breeds whose milk was typed for four genetic systems of milk proteins. Differences among breeds in gene frequency are evident for all four systems, but the following general observations were made: (1) β -lactoglobulins A and B occur in all five breeds, C has been found in rare instances in Jerseys, (2) α_{s1} -casein B is most common by far with C at low frequency in all five breeds and A being found only in Holsteins. Both of the k-casein variants occur at relatively high frequencies, but A is most common in most breeds, and (3) β -caseins A³ and C are rare or absent in all breeds and B is rare in all but the Brown Swiss and Jersey breeds. (03 31 002)

D. Swine

1. Selection for low and high backfat. Two-way selection for backfat thickness at the liveweight of 175 lb. has been carried through 13 generations in Durocs and 11 generations in Yorkshires at Beltsville. As yet, there is no indication of any of the lines approaching a plateau. Relative to the foundation populations from which the lines were developed, the difference between the two Duroc lines represents a 59% increase in the high-fat line and a 33% decrease in the low-fat line. The corresponding values for the high- and low-fat Yorkshire lines are 40 and 33%, respectively. Carcass data obtained on samples of pigs slaughtered at about 210 pounds also give evidence of a continuing divergence between the high- and low-fat lines with controls generally intermediate between the selected lines in both breeds. (03 32 002)

The effectiveness of selection for one trait, low backfat thickness, was investigated in Poland China pigs at Columbia, Missouri. Backfat probe measurements were made at a mean weight of 79.2 ± 2.5 kg. Measurements were made at three sites, shoulder, loin and ham, and the average of the

three measurements was used for selection. Mass selection resulted in approximately a 20% decrease in the backfat thickness of pigs as measured by the probe technique in five generations of selection. Response to selection at the three probe sites was similar. Realized heritability for the average of the three backfat probes was 0.32 ± 0.09 , while the heritability estimate obtained from intrasire regression of mean of offspring on dam was 0.56 ± 0.09 . The genetic correlations between backfat probes at 3 sites ranged from 0.59 ± 0.10 to 0.82 ± 0.06 , suggesting that many of the same genes affected backfat at the different sites. The results of this study showed that mass selection for low backfat thickness was an effective method for reduction of backfat thickness. (03 32 011)

2. Physiological control of pork quality. In research at Warsaw, Poland, lactic acid dehydrogenase activity was no greater in pale, soft and exudative meat (PSE) than in normal pork muscle. No interrelationship was found between enzymes controlling the glycolytic cycle/Krebs cycle and PSE pork. Protein denaturation was found to take place in PSE muscle and occurred in about equal degrees from sarcoplasmic and myofibrillar proteins. Some evidence was found that genetic origin of the animals was at least a contributing factor in the production of pale, soft and exudative pork. The progeny of some boars showed very little watery pork, while progeny from other boars were nearly 100% PSE. Reducing capacity of blood as it affects color stability of hemoglobin and myoglobin appears promising as a means for determining the degree of watery structure in pork muscle. (03 32 029)

E. Sheep and Fur Animals

1. Evaluation of wool quality. Analyses have been completed on 93 top samples which were used at Beltsville to test the repeatability and reliability of the Electronic Fiber Fineness Indicator (EFFI), and to compare it with the existing standard method for measuring the average fiber diameter and variability of wool fibers. Correlations for EFFI versus short fiber method were .92, while correlations among the three laboratories using the short fiber method were .99. There was less difference between subsamples for EFFI than for the short fiber method. Analyses are also completed on comparisons of methods of measuring staple crimp in grease wool. A new device has been developed and tested for crimp measuring. It works much faster and gives more reliable results than the previously developed scale. Fewer crimps need to be measured with the device than with the scale for the same reliability.

A new type cutter, using the preparation method of the rotary cutter developed here, but with a straight cutting action, is being tested.
(03 33 018)

Dye-striped wool samples have been obtained and measurements of quality traits started from 457 mature ewes which were under an early and late

weaning management system. The dye-stripe method has proven successful for studying growth and quality changes in wool production under seasonal or varied nutritional regimes which should detect management systems conducive to improving wool production.

There was no difference in body and grease fleece weight due to early or late weaning, or to ewes producing single or twin offspring. The rate of wool growth varied from a low of 84% just prior to and immediately after lambing to a high of 111% during summer and early fall grazing. Wool grown during fall grazing (64 days) was slightly coarser with fewer crimps than wool produced during any other grazing period, however, there was no difference in fiber diameter or crimp due to type of birth or time of weaning. (03 33 030)

2. Chemical shearing of wool. Chemical shearing of wool has been successfully accomplished with sheep at Beltsville through the use of a chemical given as an oral drench. The chemical used is a cyclophosphamide, a cancer depressant, which inhibits temporarily the mitotic activity of cells in the bulb of the wool follicle. This reduction in mitotic activity is evident at the skin surface as a constriction in each wool fiber 6 to 7 days following treatment. At this point of thinning, or constriction, the fiber breaks easily and permits removal of the wool quickly and easily by unskilled labor. Chemical defleecing leaves sheep skin unblemished, unlike shearing which tends to leave nicks and cuts in the skin. (03 34 009)

3. Physiological influences on animal fibers. Effects of physiological factors were studied in the primate, rhesus (Macaca mulatta). Hypophysectomized and castrated animals had sparse coats when compared with controls. Also, hairs of these animals plucked more easily than did hairs of controls. On the basis of length, hairs of hypophysectomized animals were comparable to those of the juvenile class, while hairs of castrates tended to be shorter and more like that of infants. Effect of sex was evident only in the length and diameter of the hairs. (03 34 009)

4. Season and priming effects on hair growth. An appraisal of effects of season on hair growth and priming was made in the primate, rhesus (Macaca mulatta). A seasonal effect was observed in mid-April in all animals studied and in July there was a marked increase in growing hairs. Although no treatment differences were observed in growth rate in adult controls, a higher rate was obtained in infants after plucking, and in juveniles after clipping. These differences, however, may be attributed to the small number of animals in each of the assigned groups. (03 34 010)

F. Broadly Based

1. Effect of growth and maturity on meat quality. In work at Beltsville, the data from beef animals slaughtered at 6, 12, 18, 24 and 30 months of

age show that those on restricted feed between 18 and 24 months of age had individual muscle and bone growth nearly equivalent to that from similar steers on full-feed at 12 months. Animals on full-feed had more separable lean in the carcass at each age interval than those from the restricted group and also had from two to three times more weight of separable fat. Animals on restricted diets until six months prior to slaughter were intermediate in weight of separable lean and fat. There was nearly twice as much intramuscular ether-extract fat in the muscles of twelve month old full-fed steers than in muscles from thirty month old restricted steers. Full-feeding the last six months did not add appreciably to the percentage of intramuscular ether-extract fat. (03 99 001)

Publications - USDA and Cooperative Programs

A. Poultry

1. Eggshell quality

Hurwitz, S., A. Bar and S. Bornstein. 1967. The effect of lactose on egg production and shell quality. Poultry Sci. 46:1024-1025.

Hurwitz, Shmuel and Arie Bar. 1967. Calcium metabolism of hens secreting heavy or light eggshells. Poultry Sci. 46:1522-1527.

Hurwitz, S. and A. Bar. 1968. Activity, concentration, and lumen-blood electrochemical potential difference of calcium in the intestine of the laying hen. J. Nutrition 95:647-654.

2. Cottonseed constituents and egg quality

Kemmerer, A. R., B. W. Heywang and R. W. Lowe. 1967. Effect of cottonseed oil on egg production and egg quality. Poultry Sci. 46:1165-1167.

B. Beef Cattle

1. Selection for changes in leanness

DeRouen, T. M., D. C. Meyerhoeffer, W. L. Reynolds, H. C. Gonsoulin and N. T. Poche'. 1968. Selection for changes in leanness in beef cattle. Eighth Livestock Producers Day Report. Dept. of Animal Sci., L.S.U.

DeRouen, T. M., W. L. Reynolds, N. T. Poche', H. C. Gonsoulin and D. C. Meyerhoeffer. 1968. Mortality of beef calves in the Gulf Coast Area. Eighth Livestock Producers Day. Dept. of Animal Sci., L.S.U.

Reynolds, W. L., H. C. Gonsoulin, T. M. DeRouen and D. C. Meyerhoefffer. 1968. Improvement of reproductive performance of beef cattle. Eighth Livestock Producers Day Report. Dept. of Animal Sci., L.S.U.

Reynolds, W. L., D. C. Meyerhoefffer and T. M. DeRouen. 1968. Different silages and molasses for beef steers. J. Animal Sci. 27:296.

Reynolds, W. L., H. C. Gonsoulin, T. M. DeRouen and D. C. Meyerhoefffer. 1968. Feeding molasses free choice to beef cattle. Louisiana Agriculture. Winter Issue 1967-68.

Reynolds, W. L., H. C. Gonsoulin, N. T. Poche', D. C. Meyerhoefffer and T. M. DeRouen. 1968. Evaluation of different silages and molasses for beef cattle. Eighth Livestock Producers Day. Dept. of Animal Sci., L.S.U.

2. Improve palatability

Neel, J. B., J. M. Anderson, C. S. Hobbs and J. A. Odom. 1967. The effect of initial winter condition and level of winter feeding on beef cow and calf performance. Tennessee Farm and Home Science. Prog. Rpt. No. 63:14-17.

Sanders, W. L. 1968. Relationship between change in condition of beef cows during the pasture season and the weaning performance of their calves. J. Animal Sci. 27:297 (Abst).

C. Dairy Cattle

1. Genetics of milk composition

Ashton, G. C., D. G. Gilmour, C. A. Kiddy and F. K. Kristjansson. 1967. Proposals on nomenclature of protein polymorphisms in farm livestock. Genetics 56:353-362.

Groves, M. L. and C. A. Kiddy. 1968. Polymorphism of γ -casein in cow's milk. Arch. Biochem. and Biophys. 126:188-193.

Groves, M. L., W. G. Gordon and C. A. Kiddy. 1968. Polymorphism of electrophoretically slow moving caseins and their relationship to γ and β -casein variants. J. Dairy Sci. 51:946 (Abst.)

Hines, H. C., E. W. Brum and C. A. Kiddy. 1968. Linkage relationships among cattle blood groups, serum protein, and milk protein loci. J. Dairy Sci. 51:975 (Abst.)

Kiddy, C. A., R. E. McCann and W. W. Thatcher. 1968. Gene frequencies in milk protein polymorphisms in dairy cattle. Immunogenetics Letter 5:150-152.

Kiddy, C. A., M. L. Groves, R. E. McCann and J. M. Treece. 1968. Effect of udder inflammation on electrophoretic patterns of cow's milk protein. J. Dairy Sci. 51:954 (Abst.)

Parry, R. M., Jr., R. J. Carroll and C. A. Kiddy. 1968. Use of antibodies to determine casein micelle structure. J. Dairy Sci. 51:943. (Abst.)

Sadler, A. M., C. A. Kiddy, R. E. McCann and W. A. Mattingly. 1968. Acid production and curd toughness in milks of different α_{s1} -casein types. J. Dairy Sci. 51:28-30.

Thompson, M. P., R. T. Boswell, R. Jenness and C. A. Kiddy. 1968. Casein pellet solvation and heat stability of cow's milk. J. Dairy Sci. 51:944 (Abst.)

D. Swine

1. Selection for low and high backfat

Gray, R. C., L. F. Tribble, B. N. Day and J. F. Lasley. 1968. Results of five generations of selection for low backfat thickness in swine. J. Animal Sci. 27:331-335.

Hetzer, H. O. and W. R. Harvey. 1967. Selection for high and low fatness in swine. J. Animal Sci. 26:1244-1251.

Peters, W. H., H. O. Hetzer and G. V. Richardson. 1967. Effect of early weaning on growth and fatness in swine. J. Animal Sci. 26:1464 (Abst.)

2. Physiological control of pork quality

Janicki, M. A., J. Kortz and J. Rozyczka. 1967. Relationships of color with certain chemical and physical properties of porcine muscle. J. Food Sci. 32:375-378.

E. Sheep and Fur Animals

1. Evaluation of wool quality

None

2. Chemical shearing of wool

None

3. Physiological influences on animal fibers

Perkins, E., T. Arao and E. H. Dolnick. 1968. The skin of primates. XXXVII. The skin of the pig-tail macaque (Macaca nemestrina). Am. J. Phys. Anthropol. 28:75-83.

4. Season and priming effects on hair growth

Roman, Nickolas, S. F. Perkins, E. M. Perkins and E. H. Dolnick. 1967. Orcein-hematoxylin in iodized ferric chloride as a stain for elastic fibers, with metanil yellow counterstaining. Stain Techn. 42:199-202.

F. Broadly Based

1. Effect of growth and maturity on meat quality

Hornstein, I., P. F. Crowe and R. Hiner. 1968. Composition of lipids in some beef muscles. J. Food Sci. 32:650-655.

Lynch, G. P., G. F. Fries and R. L. Hiner. 1968. Nutritional effects on potassium space estimates in sheep. J. Animal Sci. 27:370-376.

ANIMAL PRODUCTS FREE OF TOXIC RESIDUES
(RPA 701)

USDA and Cooperative Program

Location of Intramural Work	Commodity	Scientist
		Man-years FY 1968
Georgia	Beef cattle	0.1
Maryland (Beltsville)	Beef cattle	0.9
Virginia	Beef cattle	0.4
Maryland (Beltsville)	Dairy cattle	6.9
Maryland (Beltsville)	Swine	0.4
Maryland (Beltsville)	Sheep	0.6
North Dakota	Pioneering labs	9.0
Total		18.3

Intramural program is supplemented by extramural support representing
(a) 0.3 SMY's at State Agricultural Experiment Stations,
(b) 1.3 SMY's at other U.S. institutions, and
(c) P.L. 480 funds in 1 country representing \$7.3 thousand equivalent.

Problems and Objectives

Research on toxic residues of agricultural origin is needed to determine the circumstances under which a particular pesticide may be safely used in crop or livestock production. There is widespread public concern as to the nature and seriousness of the hazards caused by the use of pesticides in the production of farm products. Livestock and poultry producers are especially concerned, because chemical residues in meat, milk and eggs often result from animal consumption of contaminated feeds rather than direct usage of pesticides in animal production. Farmers have a vital stake in the detection and elimination of these hazards because of their possible effects on human health, the resulting hesitancy on the part of consumers to buy animal products, and the income loss that may occur if products are not acceptable.

Major objectives of the research are to:

1. Clarify the biological hazards of agricultural chemicals to man and animals.
2. Establish the residue characteristics and especially the physiological dynamics of pesticide accumulation, depletion, and excretion.
3. Seek alternatives to the use of hazardous agricultural chemicals.

Progress - USDA and Cooperative Programs

A. Poultry

1. DDT residues. In work at Athens, Georgia, when hens were given a single oral dose of 10, 15 and 20 ppm of DDT, the concentration of the pesticide and its metabolite DDE reached maximum level in the tissues from three to five weeks after administration. Abdominal fat contained 3 to 4 ppm 11 weeks after exposure. Small amounts of the pesticide were found in breast muscle, leg muscle, liver, kidney, and brain, eight weeks after dosage. The use of phenobarbital and 3-methylcholanthrene as inducing agents for the stimulation of liver microsomal enzymes had no effect on the rate of DDT metabolism with the technique used. (03 20 018)

2. Malathion residues. The chicken is very effective in degrading malathion, for only one percent of the ingested pesticide is excreted as the intact molecule. A liver enzyme, thought to be carboxyesterase, was isolated from chicken and rat liver and partially purified in a study at Ames, Iowa. The enzyme was very effective in degrading malathion. Comparison of enzyme activity of fresh chicken liver with that of rat liver showed the enzyme activity of the former to be about one-sixth of that of the latter. Although a system was developed to separate standard solutions of malathion from its mono and diacid forms and maleoxon, the technique

was not satisfactory for separating the various compounds after enzymatic degradation. The results indicate that the faster the rate of degradation, the less toxic malathion will be to an animal. (03 29 016)

3. Pesticide contamination in feed. In research at Columbus, Ohio, preliminary results of a survey of nine halogenated hydrocarbon pesticides in samples of corn, soybean meal, alfalfa meal, fishmeal, and fat, obtained on the open market in four different areas of the country, showed some samples free of pesticides; others contained only minute residue traces. Many samples contained multiple residues in the range of 0.01 to 0.1 ppm of each pesticide present. A few samples exceeded 0.1 ppm and ranged as high as 1.7 ppm. The most frequently found residues in the feed ingredients, except for corn, were DDT and its metabolites. Aldrin, dieldrin, heptachlor and heptachlor epoxide were found in corn samples. In addition to DDT and its metabolites, soybean meal frequently contained aldrin and dieldrin and alfalfa was contaminated with heptachlor, heptachlor epoxide and dieldrin. Fishmeal samples contained residues of all pesticides analyzed for except methoxychlor and toxaphene. (03 29 001)

B. Beef Cattle

1. DDT residues. In the past 10 years, at Front Royal, Virginia, DDT contamination of locally grown apple pomace has decreased from nearly 40 ppm in 1958-59 to about 1.0 ppm. Therefore, pregnant and lactating beef cows receiving it as a wintering silage are much less likely to contain legally excessive residues of DDT. In 1965-66, perianal fat biopsies from 5 cows wintered on pomace had 14 ppm DDT at calving. Sixteen weeks later, levels in the cows' fat had dropped to 4 ppm, but their calves had 7 ppm, the legal tolerance. One year later, a similar trial showed similar results, but levels in both cows and calves were much lower, reaching less than 4 ppm DDT at their maximum. Thus, it appears that DDT contamination of locally produced apple pomace presents no serious hazard to its commercial use for wintering beef cows, if the DDT content is known and feeding practices gauged accordingly. Other insecticides, e.g., kelthane, with current tolerances set at zero, may preclude commercial feeding. Additional studies of these factors are in progress. (03 30 016-3)

2. Heptachlor and heptachlor epoxide. Beef cows in confinement at Front Royal received recommended amounts of a ration containing 0.4 ppm heptachlor and heptachlor epoxide (HHE) during the last 3 months of gestation and for 6 months postpartum. Periodic perianal fat biopsies indicated that: (1) cows receiving the contaminated ration accumulated HHE at 0.01 ppm per day through the fifth month postpartum levels reaching 1.5 ppm in their external fat. During the sixth month postpartum, a decrease at about the same rate was seen; calves' contamination followed that of their dams; (2) cows receiving residue-free feed throughout the study showed no contamination, nor did their calves; and, (3) cows receiving heptachlor-contaminated feed rapidly became contaminated. Once this insecticide is

absorbed, it is very slowly dissipated by contaminated cattle. No physical symptoms of toxicity were seen in cows or calves. (03 30 038)

3. Metabolism of pesticides. In a separate study at Beltsville (1) the proportion of DDT relative to DDD and DDE was higher in milk fat and adipose tissue than in muscle and blood, (2) procedures have been developed for cannulating portal and ruminal veins of cattle to investigate the site of absorption of pesticides, (3) C^{14} excretion patterns were established for 16-alpha, 17-alpha dihydroxprogesterone in heifers. Methoxychlor, at 1.0 gm. per kg body weight, did not significantly affect excretion of this progestogen, (4) decreasing the level of intake of a concentrate or a roughage diet increased ruminal pH and the acetate to propionate ratio and decreased the concentration of VFA, respiration rate and heart rate; and, (5) feeding aldrin to beef heifers from 42 to 540 days of age at the rate of 1 mg/kg body weight did not affect performance. Feeding aldrin was associated with higher heart rates and blood lactic acid concentrations. (03 30 016-2)

C. Dairy Cattle

1. Residues of DDT. DDT and two of its degradation products, DDD and DDE, were fed for sixty days to three groups of cows at identical levels at Beltsville. Milk residues for the group fed DDT consisted of both DDT and DDD at a 40:60 ratio while the other group excreted in the milk only the compound fed. Total milk residues accounted for 5%, 7.6%, and 25.5% of the DDT, DDD and DDE fed, respectively. The patterns of milk residue which decline after dosing was stopped were different for each compound. In vitro studies showed that p-p' DDT disappearance from rumen contents at a rate of about 13% per hour with about 89% appearing as p-p' DDD. o-p' DDT disappeared at 19% per hour with only 65% accounted for as o-p' DDD.

The work demonstrates that the severity and persistence of any DDT residue problem is specifically related to the particular analog involved. Also the rumen has been identified as a major site for DDT degradation. (03 31 029)

2. Residues of Dursban. At Tifton, Georgia, Dursban was applied to corn at 4, 8, and 16 oz. per acre. The crop was ensiled the following day and fed to dairy cows for 6 weeks, starting about 2 months later. No Dursban or its oxygen analog was detected in the milk or urine from these cows. Small amounts were excreted in the feces, but the compound was almost completely metabolized. Choline esterase activity was unaffected by feeding this silage. It appears that when Dursban is used on forage crops at twice the recommended rates, no residue problem would occur. Persistency of fenthion (Baytex) on corn or Bermudagrass in the field and in silage were conducted. The pattern of persistency of fenthion and its five analogs was established. The effects of fenthion on dairy cows

were observed as a preliminary to a 1968-69 feeding trial. (03 31 028)

3. Absorption and excretion of heptachlor epoxide. The Research Contract at College Park, Maryland, under which this work was conducted has been completed. It was concluded that milk excretion is the major pathway for eliminating the body stores of heptachlor epoxide from dairy cows. Dietary treatments such as feeding iodinated casein and various levels and patterns of energy altered the heptachlor epoxide excretion pattern only insofar as milk excretion pattern was altered. Rate of absorption of the insecticide from feed was not appreciably altered by feeding vegetable fat, animal fat, calcium propionate, calcium lactate, mineral oil or bentonite. A high correlation between heptachlor levels in milk and body fat was established and placental transfer of the material was observed. Thus, an animal may contain measurable heptachlor epoxide although no direct consumption has occurred. The information gained is of value to regulatory officials and will be helpful in avoiding future residue problems. (03 31 028)

4. Metabolism of diuron. At Tuskegee, Alabama, diuron was fed to dairy cows for 30 days at 0, 5, 10, 25 and 50 ppm of dry ration. Milk residues were detectable in only the 50 ppm ration. About 90% of the diuron was excreted in the urine. The same levels were also fed to sheep for 10 days. No diuron residue was found in adipose tissue, heart, brain, muscle, or spleen following this treatment. Very low residue levels appeared in digestive tract tissue of the 50 ppm group after the treatment, but was no longer present following a 14-day clear-out period. Research is continuing, but preliminary results suggest that diuron occurring on crops is not apt to present an animal product residue problem. (03 31 067)

5. Controlling flies in and around barns.

a. Nonchemical methods. At Beltsville, Maryland, research to control fly population using nonchemical methods continues with cooperation of Entomology, Agricultural Engineering of ARS. Principal activities were devoted to improving and standardizing trap designs and usage for control of houseflies. Laboratory tests indicate effects from temperature, sex, and height of trap on response of houseflies to particular radiation wavelengths, but field tests gave contradictory results. Orange was more effective than ultraviolet at cool temp. in the lab, but orange was ineffective in barns during cool fall weather. A trap design was developed using a 15-watt fluorescent lamp and a cage to capture flies alive for tests comparing attractiveness of lamps. This eliminates influence of odors from charred insects observed with electrocutor grids previously used. Factors affecting design of attractant-toxicant traps was investigated: total surface area is directly related to effectiveness; absorbent coverings, such as gauze, are superior to metal or plastic screen for retaining insecticide; and "conventional" phosphor BL lamps are superior to Philips phosphor or BLB lamps. Numerous observations were made of the

behavior of houseflies in the vicinity of attractant lamps, and endeavors to improve trap components and trapping procedures including the effects of trap height, ambient light, lack of food or water. (03 31 045)

b. Control of flies with larvicides. Seven insecticides were tested at Beltsville for their larvicidal effect against houseflies. Three of these produced an encouraging amount of larvicidal activity in the feces. One of the materials, Gardona (Ent. 25841), has been investigated most extensively since it has shown greatest promise. Larvae mortality in the feces above 90% was observed in repeated laboratory tests when Gardona was included in the ration at 36 to 60 ppm. Reasons for some variability in results are being investigated. This material has not produced any milk residues nor undesirable physiological responses at levels up to 100 ppm over an extended period. Evaluation of Gardona under farm conditions in field-stacked manure is now in progress. (03 31 066)

D. Swine

1. Pesticide residues. At Beltsville, residue determinations were made on loin, bacon, shoulder, and ham samples from the pigs fed malathion, DDT, and the highest level of heptachlor (2.8 ppm). No malathion or malaoxon was found in any sample. DDT and its analogs were present in tissues from pigs fed 34 ppm of DDT in excess of the tolerance limit of 7 ppm. Heptachlor, for which no tolerance level is established, was present in all samples from pigs fed the compound, at levels ranging from 0.25 ppm in the loin to 1.59 ppm in ham fat and bacon. (03 32 017)

In another study, swine were treated with lindane, heptachlor, malathion, and DDT. Lindane was used as a spray for external parasites on four market weight hogs at 10 times the recommended concentration of 0.05%. The data show that lindane residues reached a peak at 4 to 7 days after treatment and that 28 days after treatment the lindane residue persisted at levels of 0.1 to 0.3 ppm in the backfat. All samples analyzed were well below the established tolerance level for lindane of 4 ppm in fat. Three levels of heptachlor (0.14 to 2.8 ppm) and one level each of DDT (34 ppm) and malathion (150 ppm) were fed to swine for 14 weeks to determine the effects of ingesting pesticide-contaminated feeds. The pesticide treatments had no effect on the health, mortality, growth rate, or efficiency of the pigs. Residues from pigs switched to the control diet for a 4-month period after treatment with heptachlor and malathion, but not DDT, were low enough to obtain market clearance. (03 32 018)

2. Control of flies without use of chemicals. Four types of swine housing and waste disposal were studied at Lafayette, Indiana: Type (A) an open-front, shed-type house with concrete floored front; types (B) and (C) enclosed houses with partially slotted floors over pits, but with different methods of waste disposal; and type (D) an enclosed house with total floor

slotted over lagoon. In the type (A) house, the manure and bedding were removed weekly; in the type (B) house, the waste was discharged into a septic tank and lagoon; in the type (C) house, the waste was discharged into a holding tank and subsequently spread on adjacent land; and in the type (D) house, the waste was discharged into a lagoon which extends outside the house. Fly populations in type (B) and (C) houses were slightly lower than those in type (D) and substantially lower than in the type (A) house. Mosquito larvae were found in the unscreened lagoons of the type (D) house, but no larvae survived in the septic tank lagoon of the type (B) house. (03 32 016)

E. Sheep

At Beltsville, conception rate of ewes and ability of rams to settle ewes were not affected by feeding 200 and 1000 ppm of methoxychlor or 270 and 1350 ppm of malathion in alfalfa pellets. Death losses of lambs did not appear to be affected by level of insecticide in dam's feed. Wool from lambs reaching market weight contained 0.2 to 5 ppm methoxychlor and 0.05 to 0.50 ppm malathion. Samples of edible meat contained from 0.05 to 0.16 ppm of methoxychlor. Methoxychlor was generally found in body fat stores and ranged from 0.22 to 1.82 from the low level methoxychlor group and from 3.0 to 14.2 ppm from the high methoxychlor group. (03 33 020)

F. Broadly Based

This broadly based research is largely basic in nature and is conducted at the Metabolism and Radiation Laboratory at Fargo, North Dakota.

1. Metabolic fate of Mobam. A dairy cow weighing 530 kg was dosed with 1.325 grams (1.9 mg/kg; 462.4 microcuries of Mobam- ^{14}C , ring-labeled) to determine the excretion of the chemical in the milk, urine, and feces. Tissue residues of ^{14}C were determined 72 hours after dosing. Seventy percent of the ^{14}C was excreted in the urine within 8 hours. After 24 hours, 98% of the dose was excreted in the urine (87%) and feces (11%). Milk residues as Mobam- ^{14}C equivalents were 1.35 ppm and 0.10 ppm for samples taken at 0-8 and 16-24 hour periods. Milk samples taken at 8-hour intervals during the next 48 hours were below 0.05 ppm in residues. Partitioning into chloroform suggested that 95% of the milk residue was not Mobam or its hydrolysis product, 4-hydroxybenzothiophene. The cow was slaughtered at 72 hours and tissue samples (kidney fat, omental fat, blood, lung, liver, spleen, heart, kidney, muscle, and brain) were removed. Brain and kidney fat contained 0.10 and 0.05 ppm, respectively. The other tissues were below 0.05 ppm (the lowest level detectable) in residues. Urinary metabolites identified are 4-benzothiophene sulfate and 4-benzothiophene glucuronide and a sulfuric acid ester not completely identified. (03 99 003)

2. Absorption mechanism of carbamate. Absorption studies with the carbamate pesticides, Mobam, Baygon, Carbaryl, Zectran, and Barban, have been conducted with duodenal and ileal isolated intestinal loops established in swine. Initial observations suggest that the absorption mechanism of the carbamates differs from that of glucose. The inclusion of polyethylene glycol in the perfusion solution to solubilize the carbamates appeared to decrease the rate of absorption by about one-third of that observed with physiological saline solutions. Absorption tests with Mobam and Baygon suggest that the rate of absorption from the Thiry-Vella loop of the ileum is slower than that from a Thiry-Vella loop of duodenum. Evidence has been obtained in these absorption tests to indicate that the carbamates are degraded in varying degrees during the course of the perfusions. (03 99 004)

3. Metabolism, accumulation and excretion of dieldrin. Analyses of samples from the feeding and slaughter phases of an experiment designed to study the metabolism, accumulation, and excretion of dieldrin by sheep has been completed. Statistical analyses of data from the first replicate of sheep indicate that the amount and duration of dieldrin fed has a highly significant effect on accumulation of dieldrin in body tissues. The level and source (fat or carbohydrate) of energy consumed had no effect on dieldrin accumulations. Approximately 8% of the radiolabeled dieldrin was excreted in the urine. Solvents that extract dieldrin did not extract the urinary radioactivity. Evidence to date suggests that two or more metabolites are present. Studies were initiated on chlorinated hydrocarbon accumulation in the body fat of chickens and the relationships of such accumulation to survival on subsequent feed restriction. A ration containing 20 ppm or more dieldrin was lethal to chickens during the feeding phase of the experiment, and surviving chickens died sooner on feed restriction. A level of 10 ppm dieldrin in the ration was not lethal and did not significantly affect time of death during starvation. A second experiment with controlled feed intake is in progress, as well as associated analytical work. (03 99 005)

4. Metabolism of chemicals by rumen microorganisms. In respirometric-volatile fatty acid studies, bacteria from ruminal digesta were exposed to 18 ^{14}C -labeled pesticides for 72 hours, monitored for $^{14}\text{C}\text{O}_2$ evolution, and analyzed for ^{14}C distribution. The nitro-heterocyclic (i.e., Atrazine, Propazine, Simazine), chlorinated hydrocarbon and aromatic (pyridinyl, urea, mercurial, quinoaline, amide) pesticides were stable in this microbial system. Organophosphate (i.e., Bidrin, Diazinon, Guthion), aliphatic hydrocarbon (Tabutrex), a carbamate (Mobam) and an aromatic (Trifluralin) pesticide were unstable. Pesticide R- groups susceptible to cleavage or reduction were methyl-, propyl-, carbamate-, nitro, and phosphorothioate. Breakdown of Tabutrex, an insecticide repellant for flies on animals and premises, was indicated in a rumen microbe-seeded medium. Succinic, propionic, and butyric acids increased in these cultures. Data developed

suggest that young calves propagate rumen bacteria capable of hydrolyzing tributyrin and Tabutrex. Calves with ciliated protozoa compared to calves without ciliated protozoa tended to have lower average daily gains, approximately equivalent cellulose digestion and rumen digesta dry matter, lower rumen anaerobic viable bacterial counts, lower digesta volatile fatty acid concentrations but higher propionic acid production, and apparently less ruminal digesta long-chain saturated aliphatic acid content. (03 99 006)

5. Metabolic fate of estrous-control chemicals. MATCH (ICI 33,828) was synthesized with ^{14}C to study its metabolic fate in the rats and swine. Rats were fed 300 μg MATCH daily for 20 days, dosed with the radiolabeled compound, and sacrificed at 24 or 28 hours. Of the radioactivity administered, approximately 0.5% was recovered in the respiratory CO_2 , 83% in the urine, 11% in the feces, and 2.3% remained in the body tissues at the end of 48 hours. Gilts were fed MATCH at a level of 1 or 2 mg per kg of body weight for 10 to 14 days prior to and following dosing with the ^{14}C -labeled compound. In 48 hours, 70% of the radioactivity had been excreted in the urine; over the 8-day collection period, 93.5% of the radioactivity was recovered in the urine, with 5.5% appearing in the feces. Chloroform extracted 25 to 45% of the radioactivity from the gilt urine. Infrared spectra of the two metabolites present in this extract were identical with the spectra of authentic thiodiazole and MATCH. The amounts of the two metabolites varied from about 1:1 to 1:3 (thiodiazole:MATCH). The higher proportion of MATCH may be associated with the higher level of intake and/or the quantity of urine collected during the first 24 hours after dosing. Resin chromatography indicates the possibility of 15 or 20 metabolites, although some of these may be artifacts of separation. Two relatively pure fractions, representing a major portion of the total radioactivity, have been isolated. (03 99 007)

6. Metabolite formation of triazine herbicides. The metabolism of triazine herbicides is being determined utilizing the pathway of Atrazine metabolism as typical of these compounds. Urinary metabolites soluble in tetrahydrofuran-ethyl ether were isolated and purified by (1) gel filtration, (2) thin-layer chromatography, (3) a second gel filtration, and (4) gas-liquid chromatography. Three of the components of the organic-soluble fraction were identified by infrared, NMR, and mass spectrometry as the dealkylated products of Atrazine: 2-Cl-4, 6-diamino-s-triazine; 2-Cl-4-amino-6-ethylamino-s-triazine; and 2-Cl-4-isopropylamino-s-triazine. These metabolites represent approximately 15% of the urinary excretion of Atrazine. Chemical investigations of the water-soluble metabolites of Atrazine metabolism suggest that these components can be purified by ion-exchange celluloses, gel filtration, and derivatization. To facilitate and verify the identification of the triazine metabolites, synthesis of a series of triazine compounds, including hypothesized metabolites, has been accomplished. Investigation of the NMR spectra of these triazines suggests that they may exist in rather stable tautomeric forms. (03 99 008)

7. Carbaryl metabolism in poultry. Research on the metabolism of pesticides in poultry was initiated with a study of carbaryl metabolism (1-naphthyl N-methyl carbamate) in the mature hen. Hens, surgically modified to allow the separate collection of urine and feces, were dosed with carbaryl-1-naphthyl 1-¹⁴C or carbaryl-carbonyl ¹⁴C at a rate of 10 mg of carbaryl per kg of body weight. Approximately 50% of the radiolabeled carbonyl compound was expired in 48 hours; whereas no ¹⁴C from the ring-labeled compound was detected in the expired gases. Of the ring-labeled carbaryl radioactivity, 94% was excreted in the urine, whereas only 32% of the activity from the side-chain label appeared in the urine. However, the position of the label had little effect on the percentage (7.5%) of the dose that was excreted in the feces. The body tissues retained 2.6% of the activity of the ring-labeled dose. The ether-soluble metabolite in the urine was isolated and identified as naphthol. Studies to determine the nature of the polar metabolites are in progress. Eggs were collected for 12 days after a single oral dose of ring-labeled carbaryl at a rate of 10 mg per kg body weight. The activity in both the yolk and the white declined rapidly from the initial level, with 0.32% of the dose recovered in the eggs. (03 99 009)

Publications - USDA and Cooperative Programs

A. Poultry

1. DDT residues

None

2. Malathion residues

None

3. Pesticide contamination in feed

None

B. Beef Cattle

1. DDT residues

Rumsey, T. S., K. P. Bovard, B. M. Priode and M. L. Crandall.
1967. DDT residues in beef cows fed apple pomace. J. Animal
Sci: 26:880. (Abst.)

2. Heptachlor and heptachlor epoxide

Bovard, K. P., J. P. Fontenot and B. M. Priode. 1967. Heptachlor residues in steers fed contaminated alfalfa. J. Animal Sci. 26:914 (Abst.)

3. Metabolism of pesticides

Rumsey, T. S., P. A. Putnam, R. E. Davis and C. Corley. 1967.
Distribution of p,p'-DDT residues in adipose and muscle tissues
of beef cattle. J. Agr. Food Chem. 15:898.

Rumsey, T. S., P. A. Putnam, James Bond and R. R. Oltjen. 1967.
Effect of feed intake on ruminal pH and VFA. J. Animal Sci.
26:928. (Abst.)

C. Dairy Cattle

1. Residues of DDT

Fries, G. F. and E. A. Kane. 1967. Retention of DDT and DDE by the
bovine. J. Dairy Sci. 50:1512-1514.

Fries, G. F. 1968. Metabolism of DDT by rumen microorganisms in
in vitro. J. Dairy Sci. 51:981 (Abst.)

2. Residues of Dursban

Beck, E. W., J. C. Johnson, Jr., M. E. Getz, F. B. Skinner, L. H. Dawsey,
D. W. Woodham and J. C. Derbyshire. 1968. Effects of feeding
dimethoate, its oxygen analog, and dimethoate-treated silage to
cattle. J. Eco. Ent. 61:605-609.

3. Absorption and excretion of heptachlor epoxide

None

4. Metabolism of diuron

None

5. Controlling flies in and around barns

a. Nonchemical methods

Morgan, N. O. 1967. Control of horn flies by an electrochemical
device. J. Eco. Ent. 60(3):750-752.

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pupae of the face fly. J. Eco. Ent. 60(5):1464-1466.

Pickens, L. G., N. O. Morgan, J. G. Hartsock and J. W. Smith. 1967.
Dispersal patterns and populations of the housefly affected by
sanitation and weather in rural Maryland. J. Eco. Ent.
60(5):1250-1255.

Pickens, L. G. and N. O. Morgan. 1967. A simplified laboratory technique for separating eggs of the face fly from oviposition medium. J. Eco. Ent. 60(5):1479.

Pickens, L. G., N. O. Morgan, J. G. Hartsock and J. W. Smith. 1967. Dispersal patterns and populations of the housefly affected by sanitation and weather in rural Maryland. J. Eco. Ent. 60:1250-1255.

b. Control of flies with larvicides

Bowman, M. C., M. Beroza, C. H. Gordon, R. W. Miller and N. O. Morgan. 1968. A method of analyzing milk and feces of cows for coumaphos and its oxygen analog after feeding coumaphos for control of housefly larvae, Musca domestica L. J. Eco. Ent. 61:358.

Miller, R. W., C. H. Gordon, R. C. Kling, N. O. Morgan, M. C. Bowman and M. Beroza. 1968. Feeding of gardona treated corn silage for the control of manure breeding flies. J. Dairy Sci. 51:961 (Abst.)

Miller, R. W., C. H. Gordon, N. O. Morgan, M. C. Bowman and M. Beroza. 1967. Evaluation of SD 8447 as a feed additive larvicide. Proc. of 1967 National Meeting of Entomological Society of Am. (Abst.)

D. Swine

1. Pesticide residues

None

2. Control of flies without use of chemicals

None

E. Sheep

None

F. Broadly Based

1. Metabolic fate of Mobam

None

2. Absorption mechanism of carbamates

None

3. Metabolism, accumulation and excretion of dieldrin

None

4. Metabolism of chemicals by rumen microorganisms

Fulghum, R. S., B. B. Baldwin and P. P. Williams. 1968. Antibiotic susceptibility of anaerobic ruminal bacteria. Appl. Microbiol. 16:301-307.

Williams, P. P. 1968. An analysis of pesticide stability in anaerobic bacterial suspensions. Bacteriol. Proc. Amer. Soc. Microbiol. p. 5 (Abst.)

5. Metabolic fate of estrous-control chemicals

Aschbacher, P. W. 1967. Thyroid physiology in lambs as affected by iodine supplementation of the pregnant ewe's diet. J. Animal Sci. 27:127-130.

Aschbacher, P. W. and V. J. Feil. 1968. Metabolism of 3, 5 diiodosalicylic acid in cattle and rats. J. Dairy Sci. 51:762-766.

6. Metabolite formation of triazine herbicides

None

7. Carbaryl metabolism in poultry

None

PROTECT ANIMAL PRODUCTS FROM HARMFUL MICROORGANISMS AND TOXINS
(RPA 702)

USDA and Cooperative Program

Location of Intramural Work	Commodity	Scientist	
		Man-years FY 1968	
Maryland (Beltsville)	Dairy cattle	0.1	
Wisconsin	Dairy cattle	0.3	
Total		0.4	

Intramural program is supplemented by extramural support representing
(a) 0 SMY's at State Agricultural Experiment Stations,
(b) 0 SMY's at other U.S. institutions, and
(c) P.L. 480 funds in 0 countries representing \$0 equivalent.

Problems and Objectives

Agriculture has the responsibility to ensure the production of foods safe to eat and of nonfood products safe to use. The United States enjoys a reputation for food supplies that are, microbiologically speaking, among the safest in the world. Nevertheless, expanded reporting on communicable diseases indicates that Salmonellosis in humans is a significant problem. The majority of foodborne outbreaks of Salmonellosis involve food products of animal origin. To reduce the risk to man from these and other harmful microorganisms and toxins, agriculture must ensure that its products are safe to eat or use.

Harmful mycotoxins may occur in animal products. The use of antibiotics as feed additives may contribute to the occurrence of populations of antibiotic-resistant microorganisms in the environment.

Major objections of the research are to:

1. Identify and eliminate sources of salmonella infections in poultry.
2. Eliminate or control the sources of mycotoxins that occur in stored forages and grains used to feed livestock.
3. Determine the influence of feeding antibiotics to animals on their performance and on the existence of populations of antibiotic-resistant microorganisms.

Progress - USDA and Cooperative Programs

A. Dairy Cattle

1. Effects of mycotoxins when fed to dairy cattle. Work has continued at Beltsville on a limited scale on identifying and quantifying the physiological responses of dairy calves to the various levels and periods of aflatoxin dosing. Intakes of .04 to .10 mg/kg body weight per day resulted in reduced feed intake, reduced body weight gains, reduced serum vitamin A, and increased serum alkaline phosphatase activity. Histological examination of liver tissue showed bile duct hyperplasia and a loss of glycogen. Livers of these calves also showed fatty infiltration, some containing 38% fat after six weeks of treatment. The data developed will allow the association of field observed physiological responses with likely levels of aflatoxin intake. Work is now in progress to identify the responses occurring from a single large dose of aflatoxin. Studies are underway to develop the meadow vole as a test animal for small samples of forage and grain. Work is centered on development of a semi-purified basal diet which will serve as a basis for comparing experimental feeds. A diet containing 8% protein and 30% wood pulp appears adequate. (03 31 042)

2. Fungal toxins in forages. At Madison, Wisconsin, the development of fungi as affected by crop, moisture content, and storage conditions was studied on six harvests of alfalfa and two harvests of brome grass. Fungal growth was greatest at the higher moisture contents with all forages. *Aspergillus flavus* (the source of aflatoxin) was naturally present on three of the alfalfas harvested, but was missing in the brome grass. This organism developed readily on all forages when inoculated. The extent of aflatoxin present under these various conditions is presently being determined. *Aspergillus flavus* did not grow in pilot corn plant silos over a 7-day period when O₂ content of the atmosphere ranged from 0 to 8%. No conclusions or recommendations can be made from this work until analyses for aflatoxin are complete. (03 31 020)

B. Swine and Poultry

1. Antibiotic resistance in enteric microorganisms. In a one year contract with the Battelle Institute, Columbus, Ohio, bacteriological baseline studies made prior to treatment showed that both pigs and chickens harbored chlortetracycline-resistant bacteria. Feed ingredients were also found to contain resistant bacteria. Total numbers of enteric bacteria increased in pigs after chlortetracycline medication and the population of resistant bacteria also increased to a level of about 95% of the total bacterial count. The bacterial population of control pigs declined during the same period, and the numbers of resistant bacteria fluctuated markedly. In chickens the total numbers of enteric bacteria were unaffected by chlortetracycline addition to the feed, but there was significant increase in the percentage of resistant organisms. (03 32 032)

Publications - USDA and Cooperative Programs

A. Dairy Cattle

1. Effects of mycotoxins when fed to dairy cattle.

Lynch, G. P. 1968. The use of the meadow vole in research.
Institute of Laboratory Animal Resources News, Vol. 11:2.

Lynch, G. P., R. W. Miller, and D. F. Smith. 1968. Aflatoxin induced vitamin A changes in calves. J. Dairy Sci. 51:979.
(Abst.)

2. Fungal toxins in forages.

None

B. Swine and Poultry

1. Antibiotic resistance in enteric microorganisms.

None

ALLEVIATE SOIL, WATER AND AIR POLLUTION
(RPA 901)

USDA and Cooperative Program

<u>Location of Intramural Work</u>	<u>Commodity</u>	<u>Scientist</u>	
		<u>Man-years FY 1968</u>	
Maryland (Beltsville)	Poultry	0.3	
Maryland (Beltsville)	Dairy	0.2	
Total		0.5	

Intramural program is supplemented by extramural support representing
(a) 0.1 SMY's at State Agricultural Experiment Stations,
(b) 0 SMY's at other U.S. institutions, and
(c) P.L. 480 funds in 0 countries representing \$0 equivalent.

Problems and Objectives

Soil, water, and air are being polluted with a variety of substances, both inorganic and organic. Except for certain substances, it is not yet possible to assess the severity and extent of this pollution. The trend toward concentrated livestock and poultry production operations and spreading urban developments make pollution from animal sources an increasing problem. Soil, water, and air become contaminated with micro-organisms, dust, and odors from livestock and poultry wastes. Methods are needed for collecting, storing, moving, and disposing of animal wastes that preclude risks to human health and alleviate the odors, dust, and noise from livestock operations.

Major objectives of the research are to:

1. Develop methods to reduce the volume of animal waste produced.
2. Identify and reduce the pollution characteristics of animal waste.
3. Develop waste handling methods for animal enterprises in and around urban areas which will reduce pollution and not be prohibitive in cost.

Progress - USDA and Cooperative Programs

A. Poultry

1. Diet and excreta composition and volume. In tests at Beltsville to determine the effect of diet on volume of droppings it was found that source of protein or level of fat in the diet had little or no effect on the daily volume of feces produced by the laying hen. Since there are severe limitations as to changes that can be made in diets without affecting feed efficiency and cost, these results do not offer much hope that feces volume can be significantly decreased by dietary means. (03 29 094)

2. Control of offensive poultry odors. Enclosed chambers were used in a study at Ithaca, New York, to monitor the effluent air from caged layers and the odor composition, humidity, and temperature were determined. Studies on the efficacy of odor suppressants will be conducted using these chambers. A commercial preparation, Nilodor, when added to the manure or walls of dropping collection pits was very effective in suppressing odor. None of the odor suppressants tried appear to be economically feasible to use on a commercial basis since their use in effective quantities costs more than one cent per dozen eggs. (03 29 069)

B. Dairy Cattle

1. Chemical and physical treatment of excreta. Environmental pollution arising from cow feces would be reduced by recycling through animals before

discarding it. However, some treatment to increase the digestibility of feces is required to make such a system feasible. Eleven chemicals were tested at Beltsville for their effectiveness for increasing the digestibility of fecal cell walls. Most effective were NaOH, Na_2O_2 , and NaClO_2 , and Na_2SO_3 . In vitro digestibility of cell walls was increased from the 4-16% range to the 60-90% range by these treatments. An in vivo digestion trial with sheep showed that the dry matter digestibility of a 75% corn silage-25% treated feces ration was 3% units lower than a 100% corn silage ration. Low palatability remains as a problem, but the results encourage one to think that considerable feed value may be retrieved from feces.
(03 31 070)

Publications - USDA and Cooperative Programs

None

